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A ten-wheel compound locomotive, built by the Schenectady Locomotive Works is soon to be put in service on the Pennsylvania R. R., which has hitherto used only eight-wheel and consolidated engines as road locomotives. The total weight of the locomotive is 138,000 lbs., and it is intended to draw the fast express trains over the mountain grades west of Altoona. A 19 × 24-in. Eight-wheel engines with 78-in. drivers for the same road, are also nearly completed at the Schenectady works.

Baltimore is to have an elevated railway. The Roland Park Elevated Ry. Co., has been organized with Samuel M. Jarvis as President, and it is stated that contracts for building the line are to be closed soon.

The excellent results obtained from vitrified brick paving in some Western cities are bringing its merits into general notice. It is probable that several large Eastern cities will make a trial of brick pavements this season.

The most novel pavement on record is being tried at Palatka, Fla. The inventor has noticed the hardness of the sea beach as far back as the waves keep it saturated, and he proposes to keep the street surface saturated in a similar way, taking the water from a flowing artesian well. Perhaps the scheme may work in Florida sand, but it is evidently far from being generally applicable.

Work is in progress on a 2,000-HP. water power and electric transmission plant near Philipsburg, Mont. A timber flume, 3½ × 4 ft. and 1,000 ft. long, has been built, carrying about 3,000 miner's inches of water. This flume empties into a 35,000-gallon tank, from which a pipe 30 ins. diameter, and 1,300 ft. long, leads down the mountain side to the power house with a fall of 650 ft. The force of the water will be developed by 10 Pelton wheels connected direct to dynamos. The work is being done by the Flint Creek Electric Power Co. Messrs. Baker & Harper are the engineers.

A part of the improved sewerage system of Providence, R. I., has been put in operation, according to the "Journal" of that city. Purification is proposed at some future time, but at present, it seems that only the larger solid parts of the sewage are to be removed, by straining and the effluent discharged into the river.

The park system of Boston has just been increased by the addition of about 70 acres of land, near Franklin Park. It is reported that this new section will be used for military evolutions and field sports likely to be injurious to existing parks as now laid out. Eventually, it is proposed to have about 14 miles of boulevards, encircling a large part of the city.

An inclined plane railway is to be built at Pittsburg, Pa., running from the South Side to Mount Oliver. The grade will be 7%, and the cars will carry wagons and other vehicles as well as passengers. Dr. J. M. Duff and Mr. J. F. Grimes, of the Knoxville Land Improvement Co., are interested.

The most serious railway accident of the week was a derailment, May 29, at Lemont, Ill., on the Atchison, Topeka & Santa Fe R. R. Press despatches stated that the accident was caused by a cow and calf being caught in a cattle guard, the view of which was obstructed by a curve, so that there was no chance to stop, but Mr. H. C. Ives, Superintendent, informs us that it was not caused by a cattle guard or bridge, but was simply a case of cattle lying down on the outside of the curve and the engine not throwing them clear of the track. The engine, tender and smoking car rolled down the bank into the Desplaines River, but the passengers were all got out. There was one man killed and about ten were injured.—A passenger train on the Norfolk & Western R. R. was wrecked at a facing switch near Hagerstown, Md., May 14. The front part of the train passed safely, but the two rear cars were derailed and upset. It is said that the switch was opened while the train was passing. One man was killed and six were injured, two very seriously.

An open drawbridge caused an accident on the Central R. R. of New Jersey at Elizabeth, N. J., May 25. The draw is over the Elizabeth River, and was being closed after the passage of a vessel, when a freight train came up. It is said that the danger signal was displayed, but that the engineman did not heed the signal. The engineman blew the whistle for brakes, but there was not time to stop the train, and the engine and three cars went down. Nobody was hurt.

The timber lining of the Coosa Mountain tunnel, in Alabama, on the Columbus & Western R. R., caught fire recently and a large part of the timbering has been burned out, causing several falls of rock. The tunnel ends have been closed in order to smother the fire. The tunnel is about 2,600 ft. long.

The "City of New York" on an outward trip across the Atlantic, beginning May 18, made an average speed of 20.06 miles per hour. The course taken was 2,896 miles long, and the actual time was 20 minutes over six days.

The bill to incorporate a new Cape Cod Canal company, and aid it with state funds to the amount of $3,000,000, has been defeated in the Massachusetts Legislature, by a vote of 28 to 165.

The lining of the Cataract Construction Co.'s tunnel at Niagara Falls is about half finished, with the exception of the invert. The lower bench has been removed for 5,182 ft., leaving 1,518 ft. still to be excavated. On the canal, work is in progress removing the lower 5 ft. to grade. The wheel pit is now over 70 ft. deep. At the present rate of progress the tunnel will be completed by the middle of July.

The Trans-African Ry., which starts from St. Paul de Loando, on the East Coast, has been opened for traffic as far as Cassange, a distance of 300 miles.

Some immense irrigation works are under way in Australia. The Victorian Water Supply Department has made drawings and estimates for a new reservoir which will cost $1,250,000. The Goulburn Weir, which serves to deliver water to a channel 23 miles long leading to this reservoir, has been already constructed at a cost of about $500,000, and 15 of the 23 miles of channel have been completed at a cost of about $1,000,000.

The Chicago Railway Terminal Commission, which was discharged by the Board of Aldermen after having made a preliminary report, as noted last week, has been reappointed for a term of three months, which may be lengthened to six months, that being the time considered necessary by the Commission for the completion of its work. An ordinance has been adopted directing the Commissioner of Public Works to prepare plans for the elevation or depression or tunneling of the railway tracks on Kinzie St., at the intersection of Rush St., with an estimate of cost, and to report what arrangements can be made with the railway company toward paying the cost of the work.

The New York & New Jersey Bridge Co. had a hearing before a committee of the New York Board of Trade, May 31, at which it was stated, according to the press reports, that a recent change in the plans of the bridge called for a span of 3,200 ft. The committee was appointed by the Board to report upon the probable effect of such a bridge upon property and the commerce of the city, and a good deal of evidence was presented as to the probable depreciation of the value of uptown real estate on the west side. Mr. T. C. Clarke, the engineer for the bridge, spoke in favor of the project.

A fourth railway tunnel is to be constructed under the Palisades of the Hudson River to give the New York, Susquehanna & Western R. R. access to tide water. The bids for the work are to be opened June 10. We hope to give full details of the work later.

A new form of garbage box has recently been patented by Patrick Scanlan, of Chicago. It consists of an iron cylinder placed in a brick-lined chamber below the ground, a flange on the top of the box resting on the top of the brickwork, and the cover of the box being flush with the surface of the ground. The bottom of the box is divided and hinged, and is kept closed by a bar. The garbage wagon is fitted with a derrick for hoisting the box, and the bar being removed, the contents are dumped through the bottom without removing the cover, and the box is again lowered into its place. In this way all shoveling is avoided, and the nuisance of dust and spilled refuse avoided. It is claimed that the arrangement can be adapted for street cleaning, a grating covering the box, and the bottom of the box also consisting of a grating. When the street is flushed the water and dirt flow into the box, the water running through to the sewer, and the dirt being retained.

Open cars for the World's Columbian Exposition traffic are reported as being built at the Chicago shops of the Illinois Central R. R. They are designed to seat 110 persons comfortably, but by squeezing, about 134 persons can get seated. The cars are 45 ft. 1 in. long over the sills, and 53 ft. over all; 8 ft. wide inside, 13 ft. 9½ ins. high. There will be no steps, as the cars will run through from the Van Buren St. station to the Exposition grounds, and the terminals there will be platforms level with the floor of the cars.

One of the 4-in. nickel steel armor plates for the cruiser "New York" was tested at the Indian Head proving grounds recently. Three shots were fired from a 4-in. gun, with an initial velocity of 1,420 ft. per second. Carpenter projectiles were used, and all rebounded without piercing the plate.

Some of the docks at Liverpool are to be enlarged to receive vessels of 700 ft. length and 600 ft. beam. About $900,000 will be expended.

The Huron-Ontario ship railway scheme has been taken up by citizens of Toronto, and a public meeting to consider the enterprise was held on May 28. Resolutions were adopted setting forth the advantages of carrying grain from the upper lakes to the seaboard without breaking bulk, thus cheapening freights and benefiting producer and consumer. The Huron-Ontario Ship Railway Co. was commended as worthy of the support of Toronto, Ontario, and the Dominion generally. A committee was appointed to promote the enterprise and assist the ship railway company in all possible ways. It was also voted that in any improvements hereafter made on the St. Lawrence canals, a depth of 20 ft. of water should be aimed at. The proposed route of the railway is from Georgian Bay to Toronto, on Lake Ontario, a distance of about 66 miles. Mr. E. L. Corthell, the company's consulting engineer, estimates the cost of construction at $15,500,000. Mr. David Blain, of Toronto, one of the principal promoters of the enterprise, states that he is assured of sufficient capital to build the road as soon as the Chignecto ship railway is proved a success.

A ten-wheel passenger locomotive for the Chicago, St. Paul, Minneapolis & Omaha Ry. has been recently built by the Schenectady Locomotive Works, of Schenectady, N. Y. The principal dimensions are as follows:

Cylinders	18 × 24 ins.
Diam. of driving wheels	5 ft. 4 ins.
" truck wheels	2 " 6 "
" boiler barrel	4 " 8 "
Form of boiler	Wagon top
Working boiler pressure	170 lbs. per sq. in.
Firebox	7 ft. 6 ins. × 3 ft. 4¾ ins.
Tubes, number	240
" diameter	2 ins.
" length	12 ft. 0 ins.
Heating surface, tubes	1,497.5 sq. ft.
" " firebox	120.3 "
" " total	1,621.8 "
Grate area	25.5 "
Height, rail to top of smokestack	15 ft. 0 ins.
Wheel base, driving	11 " 6 "
" " total	21 " 7 "
Blind tires on front drivers	
Weight, on driving wheels	91,000 lbs.
" total	116,000 "
Capacity of tank	3,300 gallons
" " coal space	5½ tons

THE CHICAGO DRAINAGE CANAL.

One of the greatest engineering projects now on foot in the West is the construction of a great drainage canal to carry off to the Illinois River, and ultimately to the Mississippi by a waterway following the route shown in the small map, Fig. 1, the vast amount of sewage of Chicago, which now flows into the lake and threatens to seriously contaminate the city's water supply, as noted in our issue of May 12 and other issues. As previously stated in our columns, the Board of Trustees of the Sanitary District of Chicago has adopted plans and specifications for the excavation of the main drainage channel between Willow Springs and Joliet, Ill., and proposals will be received by the Trustees until June 8. Mr. Frank Wenter is President of the Board of Trustees, and Mr. Benezette Williams is the Chief Engineer. The general route is shown on the accompanying map, Fig. 2, and will follow the valley of the Desplaines River, being located north

Fig. 1. Map of Proposed Waterway from Chicago to the Mississippi River.

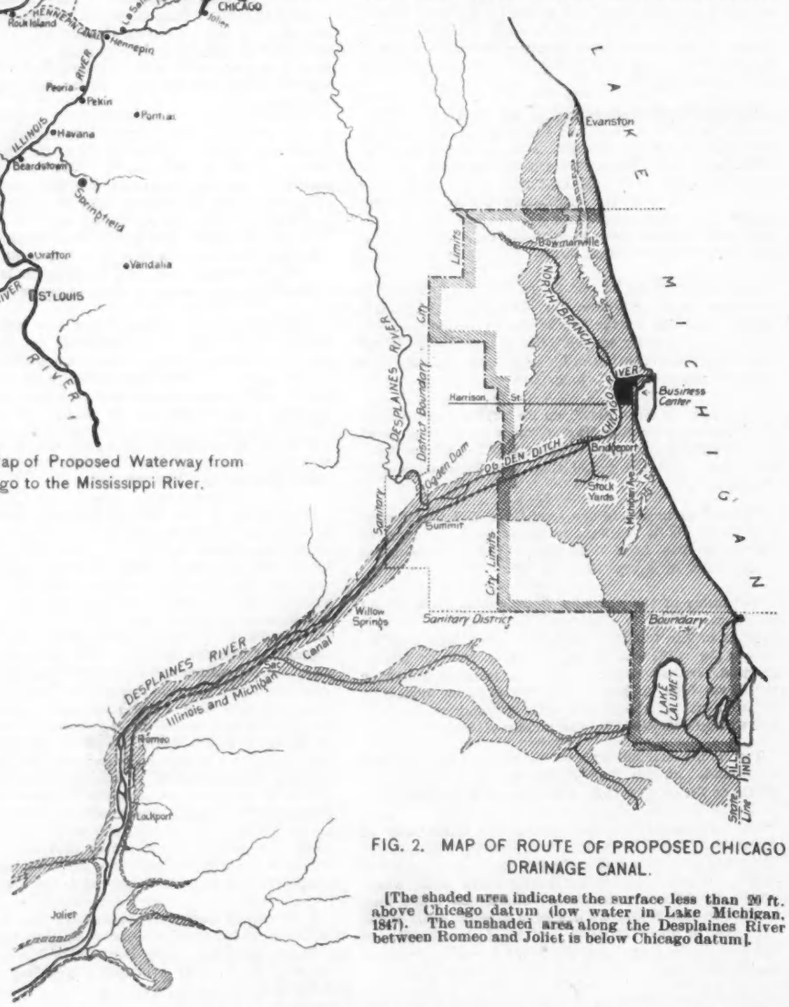


FIG. 2. MAP OF ROUTE OF PROPOSED CHICAGO DRAINAGE CANAL.

[The shaded area indicates the surface less than 20 ft. above Chicago datum (low water in Lake Michigan, 1847). The unshaded area along the Desplaines River between Romeo and Joliet is below Chicago datum.]

and west of the Illinois & Michigan canal. The work will include about 11,500,000 cu. yds. of rock and 5,000,000 cu. yds. of earth excavation, building 287,241 cu. yds. of dry rubble walls, and laying 244,444 sq. yds. of slope paving. Proposals will be received on three different propositions for different routes, and as the question of which proposition will be acted upon will not be determined by the Board until after the proposals are received, bidders may make three alternative bids, based upon the three sets of specifications. Proposition No. 1 is for a channel from Willow Springs to a point near Lockport, Ill., total length, 86,000 ft., or 16¼ miles, and divided into 16 sections. Proposition No. 2 is also for a channel from Willow Springs to a point near Lockport, Ill., total length, 74,000 ft., or 14 miles, divided into 14 sections. Proposition No. 3 is for a channel from Willow Springs to the upper basin at Joliet, 16¼ miles of excavation, and 2¼ miles of channel below the end of the excavation; total length 18½ miles, divided into 17 sections. The standard cross-sections are shown in Figs. 3 and 4. The following particulars are taken from the specifications and refer to the work in general, being the same for the several routes.

The bottom of the channel is to have a grade of 0.008 per cent., and the width at the bottom is to be 160 ft. In rock the sides are to be vertical, except as to necessary offsets occasioned by the use of a channeling machine, and except on one section where the sides are to be on a slope of 1 to 1. Where the channel is partly in earth or glacial drift, and partly in rock, a berm at least 5 ft. wide is to be left on top of the rock, and when entirely in earth there is to be a berm 10 ft. wide at a height of 5 ft. above datum, with a slope of 6 ins. toward the channel. Earth is to be taken out to the least slope which can be safely maintained until the retaining walls are built. The sides of the rock channel are to be worked out with a channeling machine from top to bottom, and left as smooth and solid as possible. In determining the width of channel at the top of the rock the necessary offsets made by the machines are to be provided for, but only one cut or reach of the machine is to be made with a depth of rock not exceeding 16 ft., two cuts with a depth of 24 ft., and in no case exceeding three cuts. For the section on which slopes of 1 to 1 are to be made, they are to be worked off by the use of core drills or such other drills as will give the required slope.

Where the top of the rock at the sides of the channel is less than 5 ft. above datum, the sides above the rock are to be faced with dry rubble retaining walls. If the bottom of the channel is in earth or glacial drift, the walls are to be founded on a footing laid in a trench, and to be 12 ins. below grade and project 12 ins. beyond the face of the wall. If the bottom is in rock, the walls will be founded upon the surface of the rock. The walls are to be built to a height of 5 ft. above datum. The thickness at top is to be 4 ft., and at the bottom is to be half the total height, and never less than the top thickness plus the total batter. The thickness at any point is to be at least half the height above that point. The back is to be in vertical planes with offsets. The batter of the face is to be 1 in 8, giving a width of channel of 166 ft. at the top of the walls. The retaining walls are to be built of stone taken out of the excavation, in courses 12 to 30 ins. thick, laid to break joint, and all spaces filled with smaller stones. The back filling between the wall and the slope of the excavation, on the sides of any depressions, is to be of broken stone or gravel, the top surface inclined 1 in 10 toward the wall. On one section (Section No. 16, the Joliet end) the sides of the channel above the natural surface of the rock will be formed of banks of loose rock to a height of 8 ft. above datum, with slopes of 1 to 1, paved evenly with stones 12 to 16 ins. thick.

Where the Desplaines River is to be diverted a channel will be excavated to 1 ft. below the level of low water, and to a width of 200 ft., with slopes of 1 to 1, and levees will be built. The ground will be cleared and grubbed to a width of 150 ft. on each side of the center line of the channel. The levees are to be 16 ft. wide, with slopes of 1½ to 1 and a berm of at least 80 ft. is to be left between the foot of the levee and the edge of the channel. All banks are to be made water-tight. The contractor is to do all the grading for a double track railway, with switches and side tracks, the roadbed for the main tracks being 30 ft. wide, and side tracks to be laid between the main tracks and the canal. Where the roadbed is on the same side as the levee it is to be at least 8 ft. from the slope, with a drainage ditch between it and the slope. The levees, banks, grading, etc., are to be of material taken from the excavation, and all stone in spoil banks is to be the property of the contractors for 20 years. The Board of Trustees will put in and operate pumping plant to keep water out of the excavation during the progress of the work, but the contractor is to make all provisions for drainage, including any shafts or tunnels necessary for a permanent pumping plant. All material is classed as "glacial drift" and "solid rock." The former comprises the top soil, earth, muck, sand, gravel, clay, hard pan, boulders, fragmentary rock displaced from its original bed, and any other material that overlies the bed rock. The "solid rock" will comprise all rock found in its original bed, even though it may have been so loosened from the adjacent underlying rock that it can be moved without blasting. Public roads are to be kept open during the work, and the levee is to be used as a roadway, approaches being built where required. All necessary excavations, grading, etc., required for the building of bridges, etc., is to be done by the contractor as directed by the engineer, and at the expense of the Board. In case of bridges having a center and protecting pier, the contractor is to leave a mass of rock in the middle of the channel to form this pier, the sides being taken out by a channeling machine as for the ordinary work. Spoil banks on the right of way are to have at least 50 ft. between the foot of the inner slope and the edge of the channel, and 10 ft. between the outer slope and the limit of the right of way. All contract work is to be completed and ready for inspection by April 30, 1896, unless the Board does not permit the contractor to begin work by Aug. 1, 1892. The approximate quantities are as follows:

	Prop. No. 1.	Prop. No. 2.	Prop. No. 3.
Excav., main channel:			
Glacial drift....cu. yds.	4,805,583	4,750,479	4,805,583
Rock..... "	11,590,810	10,887,598	11,590,810
Excav., river diversion:			
Glacial drift....cu. yds.	222,223	459,077	222,223
Rock..... "	.....	235,733	.....
Excav., canal diversion:			
Glacial drift....cu. yds.	.....	78,511	.....
Rock..... "	11,661,921	11,284,878	11,661,921
Excav., total:			
Glacial drift..cu. yds.	5,027,806	5,288,067	5,027,806
Rock..... "	71,111	161,547	71,111
Retaining walls. "	287,241	274,131	287,241
Slope paving....sq.yds.	84,000	.....	244,000
Levee embank..cu. yds.	569,076	.....	497,556
Railway " "	652,860	338,773	652,860
Backfilling to retaining walls. "	340,000	340,000	340,000

A correspondent, who is well acquainted with the district through which the canal will pass, and has had exceptional opportunities for studying the drainage problem, has written us in regard to the editorial on "Chicago's Standing Danger of Water Pollution," published in our issue of May 12, 1892, giving some interesting information in connection with the drainage canal project above described. He states that the maps prepared from the survey made by the U. S. Engineers for the waterway authorized under the River and Harbor Act of 1888 (Report of Chief of Engineers for 1890), show that the bed of the Desplaines River and of the Illinois River, as far as La Salle, is principally rock, and cannot therefore be eroded. The principal part of his letter we abstract as follows:

How then will an increase of flow of 5,000 or 10,000 cu. ft. per second help to prevent floods. The fact is that an additional discharge of 10,000 cu. ft. per second will drain large areas along these rivers and on the lower Illinois, and the point the Chicago people wish to make is to have the national Government become responsible for this damage. The Illinois & Michigan Canal was deepened in 1871, so that a gravity flow existed up the Chicago River from Lake Michigan, and through the canal to Lockport. This, however, did not produce sufficient current to carry off the sewage, and a lock was then built at Bridgeport with gates opening from the Lake (Chicago River), and the water pumped into the canal, raising the water in the canal and making a head of about 3 ft. against the gates. Now it is evident that the higher the lake, the less distance the water must be raised, and if the lake ever was 6 ft. above Chicago datum, the water would flow down the canal without the assistance of the Bridgeport pumps. You will notice that bids have been asked for only a middle portion of the proposed channel. No one connected with the project has yet propounded a scheme for dealing with either end. The upper end of the section advertised is about 22 miles from Lake Michigan by the proposed route. The Chicago River can carry about 250,000 cu. ft. per minute, but that will make navigation difficult. A greater quantity would destroy navigation and endanger the costly structures along the banks. How will or can the additional 350,000 cu. ft. of water per minute be obtained? The law permits (under present valuation) $10,000,000 in bonds to be issued, to be retired in 20 years, and an annual tax of $1,000,000. The project will cost not less than $40,000,000, and almost all this expenditure must be made before any beneficial results are experienced.

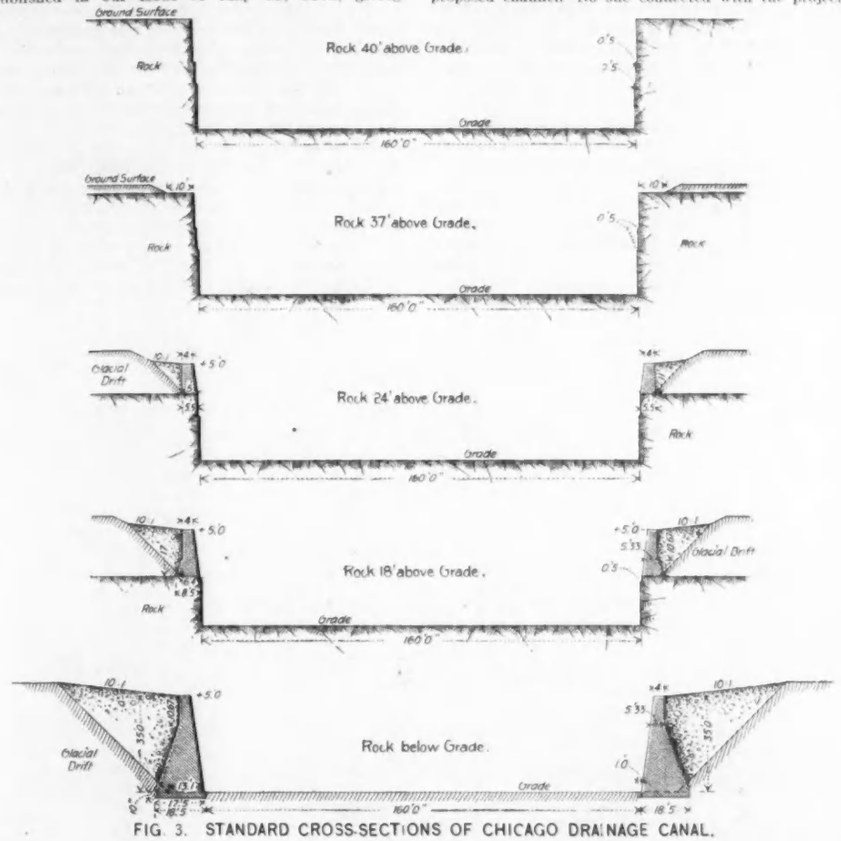


FIG. 3. STANDARD CROSS-SECTIONS OF CHICAGO DRAINAGE CANAL.

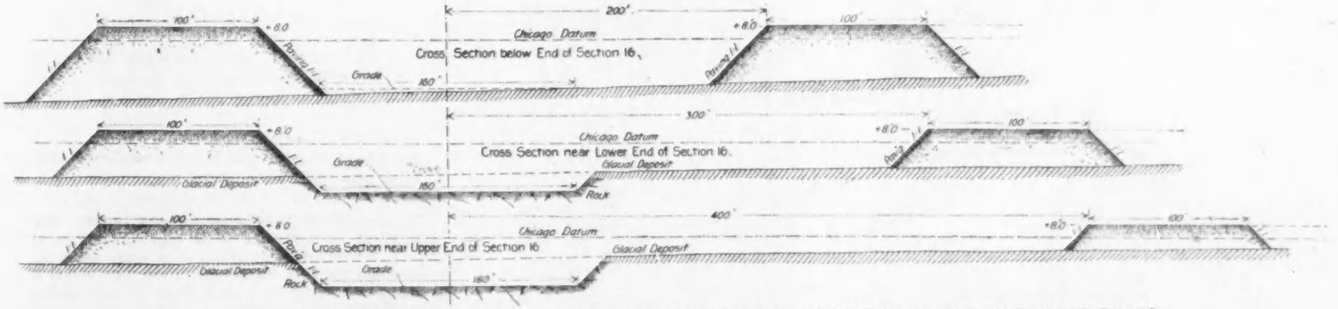

Chicago Datum
Cross Section below End of Section 16.
Cross Section near Lower End of Section 16.
Cross Section near Upper End of Section 16
Glacial Deposit
Rock
Grade

FIG. 4. CROSS-SECTIONS OF SECTION 16, CHICAGO DRAINAGE CANAL, WITH EMBANKMENTS AND SLOPE PAVING.

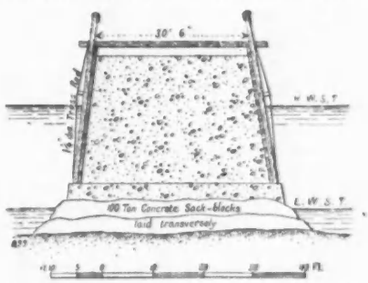
CONCRETE IN HARBOR WORKS.

An interesting description was given in a recent number of London "Engineering" on the use of unset concrete for submarine works, which we abstract as follows:

The property of developing great adhesive and cohesive strength under water, which Portland cement possesses in such a remarkable degree, even when submerged while in a plastic condition, was utilized early in the history of that material, and has permitted the foundations of sea, river, and dock walls, breakwaters, etc., to be laid under water without either cofferdams or the costly operation of pumping. Although there are great advantages connected with the use of concrete blocks for under-water work there can be no doubt that freshly-made plastic concrete has been successfully used for the same purpose, even in situations where it is exposed to the disturbing effects produced by waves, and tidal or other currents.

The harbor works at Newhaven, on the south coast, present an excellent example of the extensive use of plastic unset concrete, or, as it is frequently called, concrete in situ, this material having been almost exclusively used in the construction of the massive breakwater and other works at that port. The breakwater has at present a total length of about 1,500 ft., terminating in a depth of about 15 ft. below low water spring tides. The top of the breakwater has a width of 30 ft., is 10 ft. above high water, and is surmounted by a covered way and parapet running along the outer side, both sides battering 1 in 8.

The breakwater, which in a W. S. W. direction, is unsheltered from the force of the Atlantic, is founded on the rough natural sea bottom, and the foundation course has a width of 50 ft.; the lower portion of the structure, from the bottom up to a level of 2 ft. above low water, consists of 100-ton sacks of concrete deposited while plastic. The canvas with which the concrete was enveloped was of jute, weighing about 27 oz. per sq. yd. The sacks were dropped into place by a specially designed steam hopper barge having a well 42 ft. long, 6 ft. deep, and about 8 ft. wide. The sack-blocks in the finished work became flattened to a thickness of about 2 ft. 6 in.



Concrete Breakwater at Newhaven, England.

With the exception of this sackwork the breakwater is built of plastic concrete laid in situ. The framing was formed of timber, trussed with 1¼-in. round iron rods, as shown in the cut, spaced 5 ft. apart along each face of the breakwater, and secured at the bottom in wrought iron sockets and at the top with timber crossheads 12 × 6 ins. The sheeting consisted of 3-in. planks planed on the inside and jointed. It was found economical to build the breakwater in working lengths of 40 ft. Spring tides rise 20 ft. and neap tides about 15 ft. The concrete was generally one part cement to seven of shingle and sand; but in fine weather, concrete of one to nine was used in the hearting and on the sheltered side.

The sectional area of the breakwater, including the covered way and parapet, is about 50 sq. yds., and its construction occupied five years—from 1880 to 1885; the average rate of progress would therefore be about 15,000 cu. yds. per annum; the average cost of the concrete in the breakwater was $5.50 per cu. yd. The sand and shingle for the concrete were obtained from the adjoining foreshore.

In addition to the breakwater, concrete in situ was also used at Newhaven in the construction of two extensive sea walls and a quay wall 900 ft. in length; this material has therefore been more extensively used in these works than in any others of a similar character, and its power to resist the physical and chemical action of the sea will be a matter of great interest in harbor engineering.

At Blyth, on the coast of Northumberland, plastic concrete was used in the construction of a quay wall 712 ft. in length and founded at a depth of 15 ft. below low water; the plastic concrete was deposited under water in the usual manner with a hopper-bottomed box, which had a capacity of 16 cu. ft. A diver was employed, who directed the lowering of the concrete, and afterwards trod it into place. The concrete below low water consisted of six parts of broken stone and sand to one part of cement, by measure; above that level the proportion was seven to one, and in addition large stones were worked into the concrete. The net average cost of the concrete was $3.78 per cu. yd., which does not include plant, this latter item costing $6,380; the addition to be made to this account would amount probably to about 50 cts. per cu. yd. The stone and sand required for the concrete were obtained from ballast brought to the port by ships.

THE NEW CROTON DAM FOR THE NEW YORK WATER SUPPLY.

(With inset.)

The accompanying drawings in the text and on the inset shows the details of the New Croton Dam to be built by New York in place of the much discussed Quaker Bridge Dam. Bids for the structure, which will have a height above the bed of the Croton River of 163 ft., will be opened by the Aqueduct Commissioners on June 15, in accordance with a resolution passed May 17. The reservoir formed by this dam will have a capacity of about 30,000,000,000 gallons which with the 10,000,000,000 gallons for some time in use and the 30,000,000,000 which will be provided by reservoirs recently completed, about to be completed or under construction, will make a total storage capacity of 70,000,000,000 gallons, or a supply of about 182,000,000 gallons per day for a year. The present consumption is about 160,000,000 or 165,000,000 gallons, and by 1899, when the New Croton Dam is to be completed, will be much greater than now, unless the present per capita rate is largely reduced by meters. Of course a large part of the supply is from the natural flow of the river, storage being provided for use when this does not suffice.

The proposed Quaker Bridge Dam was first brought before the public Jan. 30, 1882, by a report from Mr. Isaac Newton, the Chief Engineer of the Department of Public Works. The capacity of the reservoir to be formed by this dam was 32,000,000,000 gallons, about the same as that of the New Croton Dam. The above named report was made before the construction of the new aqueduct was begun.

The history of the proposed Quaker Bridge Dam has been given from time to time in this journal. A concise statement of its history will be found in Engineering News of Nov. 11, 22 and 29, 1890, together with an account of the examinations of the present and other possible sites. (a)

In brief it may be said that after much discussion for about eight years, at the close of 1890 the great dam existed only on paper. Meanwhile new reservoirs had been put under construction in the upper part of the Croton drainage area, lessening the necessity for additional storage that existed in 1882.

On Oct. 8, 1890, Mr. A. Fteley, Chief Engineer of the Croton Aqueduct, reported on the building of a high masonry dam on the lower part of the Croton River in accordance with instructions given by the Aqueduct Commissioners in December, 1888. In the two years that had elapsed since the instructions were given, Mr. Fteley had made the very careful study, described in the issues of this journal named above, of the possible sites for a high dam between the present Croton Dam and the juncture of the Croton and the Hudson Rivers. In his report Mr. Fteley considered the relative advantages of three sites, namely: The Quaker Bridge, site No. 2, about a mile below the old Croton Dam, and the Cornell site, where the dam will now be built. Site No. 2 was recommended by him, as a masonry dam could be built there for a little more than half the cost of the Quaker Bridge Dam, or if the greater part of the length of the structure were of earth, as would be permissible, for less than half the cost of either the Quaker Bridge Dam or a dam on the Cornell site.

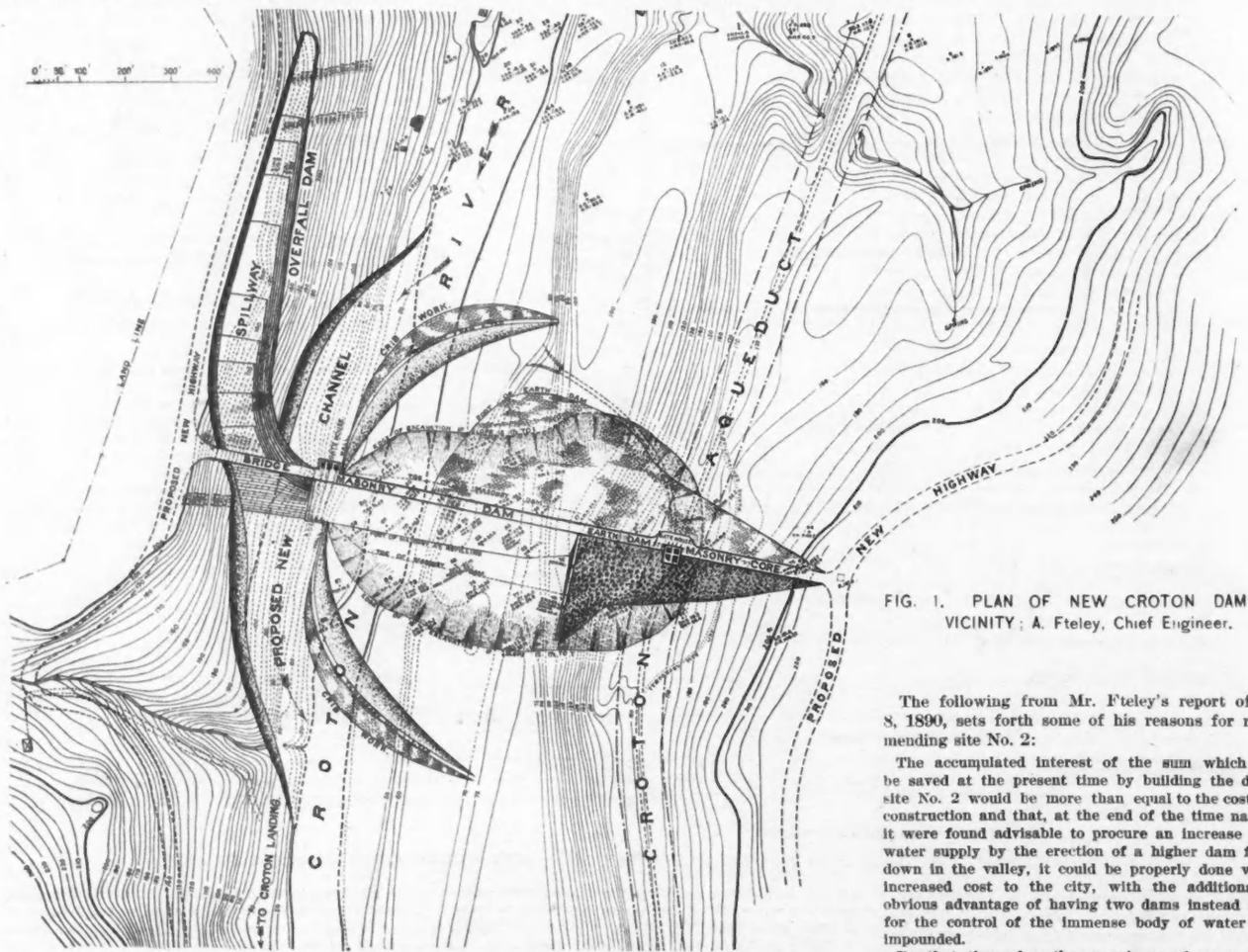


FIG. 1. PLAN OF NEW CROTON DAM AND VICINITY; A. Fteley, Chief Engineer.

The following from Mr. Fteley's report of Oct. 8, 1890, sets forth some of his reasons for recommending site No. 2:

The accumulated interest of the sum which could be saved at the present time by building the dam at site No. 2 would be more than equal to the cost of its construction and that, at the end of the time named if it were found advisable to procure an increase of the water supply by the erection of a higher dam further down in the valley, it could be properly done without increased cost to the city, with the additional and obvious advantage of having two dams instead of one for the control of the immense body of water to be impounded.

By that time also, the experience of a number of years in handling the constantly growing quantities procured from the watershed would furnish increased and invaluable knowledge in regard to its capacities; in regard to the effect of the unexceptionally large volume of the storage on the quality of the water; in regard to the subsequent advisability of accumulating the storage to add to the natural flow of dry years, and, ultimately, when the time would come for further action, in regard to an intelligent selection between an increase of the storage system of Croton water and the possible procurement of an additional and larger supply from the Housatonic River.

The relative estimated capacities of reservoirs at the three sites were as follows: Quaker Bridge, 34,000,000,000 gallons; Cornell's, 30,000,000,000 gallons; Site No. 2, 16,000,000,000 gallons. At most four years would suffice for constructing a dam on site No. 2, while five years were allowed for the Cornell and six years for the Quaker Bridge site.

(a) Those who wish more detailed accounts of the history of the dam, with illustrations, are referred to the following additional numbers of Engineering News: Specifications, with elevation, sections and details, also an editorial, April 12, 1884; "Congressman Potter vs. the Quaker Bridge Dam," editorial, Dec. 5, 1885. Reports on proposed dam by Messrs. B. S. Church, Chief Engineer of the Commission; G. W. Birdsall, Chief Engineer (old) Croton Aqueduct, and Julius W. Adams, Consulting Engineer, New York Department Public Works; also editorial, Feb. 20 and 27, 1886. Editorial, Feb. 19, 1887. "The Quaker Bridge Dam and High Masonry Dams Generally," Dec. 24, 1887. "High Masonry Dams," a report by Mr. A. Fteley, C. E., on the subject, Feb. 4 and 11, 1888. "The Design of the Quaker Bridge Dam," an editorial, accompanied by numerous illustrations, including an elevation, section and various diagrams, Feb. 4 and 11, 1888; and a letter with the last named title from M. A. Marichal, C. E., March 10, 1888. "The Plan and Location of the Quaker Bridge Dam," a report by Experts J. P. Davis, C. E., J. J. R. Croes, C. E., and Wm. F. Shunk, C. E., with illustrations and editorial, Nov. 3, 1888.

Seven years is now allowed for the completion of the dam on the Cornell site. It was thought that 16,000,000,000 gallons of storage capacity which would be made available by a dam on site No. 2 would, together with new reservoirs in the upper drainage area, be sufficient for several years to come.

The Aqueduct Commissioners, however, in January, 1891, resolved to build a dam on the Cornell site. Steps were at once taken by Mr. Fteley and

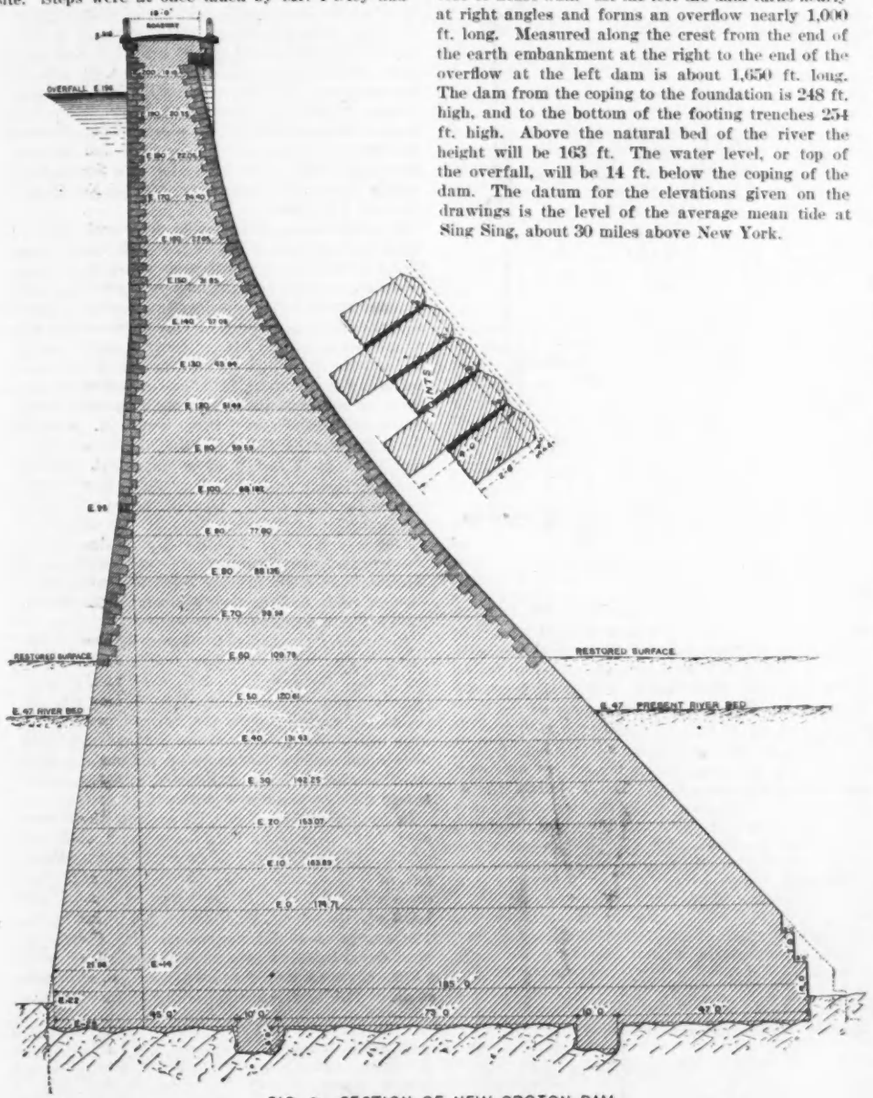


FIG. 2. SECTION OF NEW CROTON DAM.

his assistants to prepare the necessary plans and specifications, and on May 17, as already stated, the Commissioners voted to ask for bids for the construction of what will be officially known as the New Croton Dam.

The Croton drainage area and its relation to New York City were shown on an inset sheet published in our issue of Nov. 22, 1890. On the same inset the Cornell, or New Croton Dam, and other sites were shown, and a profile across the river at site No. 2, mentioned above, was given.

Fig. 1 in the text shows the plan of the new dam and appurtenances, with contours and with the results of borings. The locations of the various borings are denoted by the round black dots accompanied by abbreviations, as follows: R. for rock; G. for gneiss; W. for white or limestone; H. for hard, and S. for soft. This plan, the elevation combined with a development of the curved portion of the dam, Fig. 1 on the inset, and the section through the main dam, Fig. 2 of the text show the general character of the proposed structure. Fig. 2 on the inset shows the details at the top of the dam, including the cornice with supporting arches and coping, railings and roadway. The railing along the top of the dam seems hardly in keeping with so large and massive a structure, but possibly its design will be changed later on. An artistically designed railing of stone tracery would be more effective and its cost would not be excessive.

The main dam is a masonry structure continued at the right by an earth embankment with a masonry core or heart-wall. At the left the dam turns nearly at right angles and forms an overflow nearly 1,000 ft. long. Measured along the crest from the end of the earth embankment at the right to the end of the overflow at the left dam is about 1,650 ft. long. The dam from the coping to the foundation is 248 ft. high, and to the bottom of the footing trenches 254 ft. high. Above the natural bed of the river the height will be 163 ft. The water level, or top of the overfall, will be 14 ft. below the coping of the dam. The datum for the elevations given on the drawings is the level of the average mean tide at Sing Sing, about 30 miles above New York.

The thickness of the main dam at the base is 185 ft., and at the top 22 ft. The material used will be rubble stone masonry mostly in American cement mortar, with the foundations, the facing and the upper part of the dam in Portland cement mortar, faced as shown by the detail at the right of the top of the section, Fig. 2.

Fig. 3, also on the inset, shows a section of the dam at the gate-chamber, together with a plan (Section AB) of the small gate chamber at the outer foot of the dam and plan of the gate house. A vertical pipe connecting with the outlet pipe will extend up through the gate house to the top of the dam in order to relieve the pressure on the gates and make their operations easier. This gate house is designed to provide a means of emptying the reservoir.

Fig. 4 shows the details of the connection between the reservoir and the old Croton Aqueduct, and includes a plan of the connecting chamber and three sections. Section CD is a section through the old aqueduct. Two sections on the line AB are given, one on a smaller scale than the other in order to show the three connections between the chamber and the reservoir. The lower connection is virtually a brick conduit to permit of drawing water from the lowest possible level. By referring to the plan, Fig. 1 in the text, it will be seen that this inlet curves towards the center of the reservoir.

Fig. 5 shows the maximum, minimum and two intermediate sections through the overfall. The maximum section shows a fall for the water of nearly 150 ft., broken by 25 steps of varying heights.

Fig. 6 is a section of the earth dam, with details of its construction on a larger scale. This part of the dam, the top of which is 20 ft. above the highest water, will extend 120 ft. above the original surface of the ground and will have a top width of 30 ft., with slopes of 2 to 1. The outer slope will be sodded and will have three berms with paved intercepting drainage channels, as shown at the left of the section. The inner slope from a point 10 ft. below the top, or 4 ft. above the water line, will have a 2-ft. stone paving on 18 ins. of broken stone.

The maximum observed flow of the Croton River is 12,000,000,000 gallons in 24 hours. The construction of the dam will extend over seven years. It is therefore apparent that the providing of a temporary river channel was one of the greatest problems to be solved in designing the structure and planning the methods to be employed in its execution. In a work of such magnitude and with such a large possible volume of flow to be dealt with it was not considered wise to risk leaving an opening in the main part of the dam for the stream to pass through. The method adopted for the handling of the stream during construcure is shown in the plan, Fig. 1 in the text, and the sections through the temporary dam and channel, Figs. 7 and 8 of the inset. The different sections show plainly the character of the temporary dam and need no comment. The excavation for this new channel comprises over 150,000 cu. yds. in rock.

Some idea of the magnitude and character of the work can be obtained from the following statement of estimated quantities, taken from the specifications and form of contract:

2,000	cu. yds. soil, excavated and placed in the work.
10,000	sq. yds. sodding.
550,000	cu. yds. earth excavation.
35,000	" " " in vertical trenches.
900,000	" refilling and embankment.
150,000	" earth hauled.
300,000	" rock excavation.
320,000	ft., B. M., permanent timber work, placed and fastened.
8,000	cu. yds. crib work.
1,000	bbls. Portland cement.
10,000	cu. yds. concrete masonry, 4 parts broken stone to 1 part cement made of American cement mortar, 1 part cement, 2 parts sand.
3,000	cu. yds. concrete masonry, as above, but with Portland cement.
2,000	cu. yds. brick masonry.
470,000	" rubble stone masonry in American cement mortar, 1 part cement, 3 parts sand.
30,000	cu. yds. rubble stone masonry, as above, but with Portland cement.
50,000	cu. yds. rubble stone masonry in Portland cement mortar, 1 part cement, 3 parts sand.
12,000	cu. yds. dry rubble stone masonry paving.
5,000	" riprap, in place.
10,000	" broken stone in place.
2,500	" block stone masonry dry or in mortar.
2,500	" granite dimension stone, laid.
24,000	" facing stone masonry, laid.
15,000	sq. ft. face work for rubble stone masonry.
22,000	" fine hammered (six cut) face dressing.
12,000	" rough pointed face dressing.
8,000	lin. ft. highway fence.

The contract provides that the contractor shall be responsible for the protection of the work from the river and make good at his own expense any damage caused by the river unless it rises to a point more than 81 ins. above the stone crest of the present Croton Dam, which is the greatest height recorded by the city authorities. Damages caused by the river when above the level are to be made good by the contractor at the expense of the city.

If necessary to protect the excavation from water the contractor may be required to sink wells outside the limits of the excavation to intercept the water, which shall be removed by pumping or other exhausting apparatus.

The Aqueduct Commission, under whose direction the dam will be built, is now composed as follows: Mayor H. J. Grant, Comptroller T. W. Myers, Commissioner of Public Works T. F. Gilroy, J. C. Duane, J. J. Tucker, F. M. Scott and H. W. Cannon. Mr. Fteley is Chief Engineer of the Commission and we are indebted to him for the information given. The drawings accompanying this article and shown on the inset were originally made under the direction of Mr. F. S. Cook, Assistant Engineer.

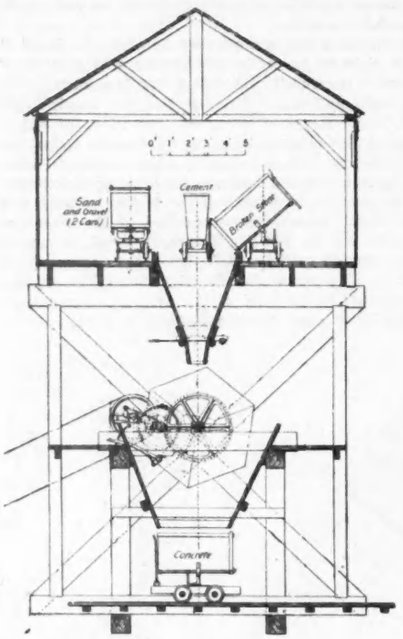
CONCRETE PLANT AT THE CASCADES CANAL, OREGON.

The Cascades of the Columbia River, Oregon, cover a reach of about 4 1-2 miles, where the river passes through a narrow gorge in the Cascade Mountains. The fall of the river in this distance is 45 ft. to 36 ft., according as it is the high or low stage of water. The United States Government is improving the river at this point by removing boulders and projecting points in the bed and banks to a 20-ft. channel, and by constructing a canal, 3,000 ft. long, at the Upper Cascades fall and across the neck of a projecting spur. This canal is to be provided with a lock and is to admit the passage of vessels up to a 20-ft. stage of water.

Active operations in construction were commenced in September, 1890, and continued since that date under the charge of Major Thomas H. Handbury, Corps of Engineers, U. S .A. From the report of Lieut. Edward Barr, Corps of Engineers, to Major Handbury, we abstract the following points relating to the concrete plant used in building the lock and other general features of construction:

This lock and the side walls are built of concrete faced with granite and basalt, and at the end of June, 1891, 9,614 cu. yds. of concrete had been made and laid. Of this amount 1,777 cu. yds. were mixed by hand and 7,837 cu. yds. by machine. The estimated total quantity of concrete required is 70,000 cu. yds., and to prepare and handle this mass economically the machinery here illustrated was used. Portland cement is used, brought to the ground via the Union Pacific R. R., and at least one barrel in every ten tested before use. The stone used is the basalt from the refuse of the stone-cutting yards; though basalt, says Lieut. Barr, is not entirely suitable for concrete as it breaks into flakes instead of cubes. This stone is brought in cars to the site of the plant and is there dumped into the hopper of a No. 5 Gates crusher, with a capacity of 30 tons per hour. The crushed stone falls into a screen which rejects all that will not pass through a 2 1-2-in. hole. The rejected stone falls into a Blake crusher and is again reduced in size. All the crushed stone, dust included, is caught in a bin below, and used without washing. As to this dust the report states that numerous tests, covering several years, show that this basaltic crusher dust is better than the best natural sand found in the vicinity of these works, and is an excellent sand under any conditions. Practice shows that this dust does not cover the broken stone so as to prevent it from being properly coated with mortar.

The sand in the Columbia River is not suitable, anywhere within reach of this work. But a bed of mixed sand and gravel was found near by that answered the purpose; it requires washing, however, to rid it of earthy matter. This washer is a barrel of boiler iron 17 ft. long and 2 1-2 ft. in diameter, provided with 4 inside wings of angle iron, and revolved by a belt on 4 12-in. rollers. The barrel is set on an inclination of 1 in. to the foot. For a length of 4 ft. the barrel is perforated with 2 1-2-in. holes, and outside of this are two other screens of 5-16-in. for sand, and wire gauze, 30 meshes to the inch, for the water. The material is conveyed on cars to the machine and the large cobblestones are picked out. The remainder is dumped into the hopper at the high end of the tube and washed by water coming from a 3-in. perforated pipe projecting into the barrel. The sand and gravel are dropped into neighboring bins and the waste water is caught in a flume. The difficulty has been to drain the sand of the muddy waste water adhering to it.



Cross-Sections of Concrete-Mixer.

This has been partially accomplished by catching the sand on a stationary screen in the bin.

The concrete mixers are of the cubical box pattern, 4 ft. on each edge, and made of 1-4-in boiler iron and 2 1-2-in. angle bars. A 3-in. shaft passes diagonally through the opposite corners of the box, and the box makes nine revolutions per minute.

The cars used in handling the mixture include bottom dumping arrangement for the cement cars and side dumps for the others. The materials for a charge of the concrete mixers are drawn into these cars and dumped into the mixer-hopper, the cement from above, the sand and gravel from one side and the stone from the other. This hopper has a sliding door of iron controlling the charge to the mixer. Water is added as the charge drops into the mixer. The two mixers are run by a hoisting engine with 7x10 in. cylinders, and a vertical boiler 3 ft. in diameter and 7 ft. high, the steam at 30 lbs. pressure.

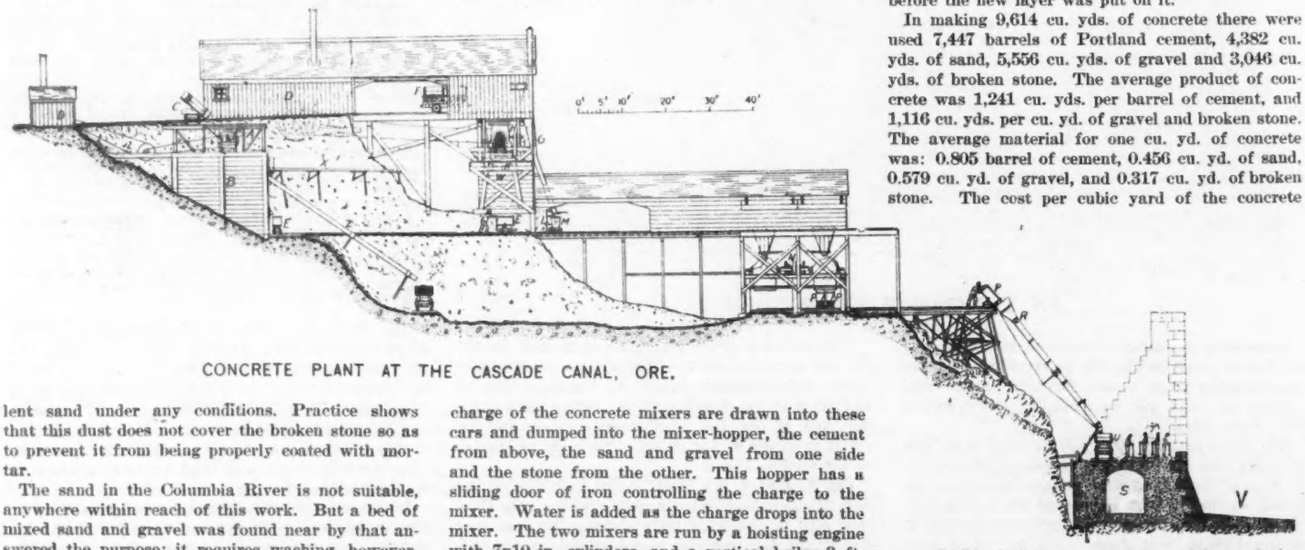
The volume of the charge varied with circumstances; 32 cu. ft. was the usual allowance, and 15 revolutions in 1 1-2 minutes was found sufficient to thoroughly incorporate the mass. The average work of the mixer was about 17 charges, or 13 cu. yds. per hour if the materials were freely supplied and the output promptly removed.

The work under construction extended from the level of the tracks under the mixer to 50 ft. below these tracks. To handle the concrete on these varying levels chutes were used made of thin wrought iron with a hopper at the upper end and a 45-degree elbow at the lower end to prevent scattering. This chute was 16 1-2 ins. in diameter, with a hopper 5 ft. long and a top 3 1-2 wide. The lower end was supported by two telescopic legs of gas pipe and at the top by a truss frame of wrought iron with two wheels running on a track. It was trussed horizontally and vertically by four stays each made of two strands of 5-8-in. steel wire rope that had been worn until unfit for hoisting purposes. As first made the chute was riveted up in 6-ft lengths, and then connected by slip joints and stove bolts, so as to allow the shortening of the pipe, as the wall rose. But the wear on the bolt and rivet-heads compelled resort to outside flange joints. The hopper was made of No. 12 iron and the chute of No. 14 iron, and to take up the wear and save the more expensive outside pipe, this was finally lined with a cheaply made secondary pipe of No. 18 iron made in 3-ft. lengths.

In construction the concrete was used in large masses, the bottom width of the wall varying from 29 to 59 ft., and the calculated strain on the masonry ran as high as eight tons per square foot. The foundations started on conglomerate worked to grade and all soft parts removed. This conglomerate was first covered with 8 ins. of concrete made in the proportions of 1 part cement, 2 sand and 4 stone or gravel. For the lower 14 ft. of the lock walls, and 10 ft. of the gate abutments, the proportions were 1 cement, 3 sand and 6 stone or gravel. And for the remainder of the work the proportion was 1 cement, 4 sand and 8 stone or gravel. Mortar, made 1 cement to 4 sand, was about equal in volume to the sand alone. The percentage of voids in the coarser material was about 36 for gravel and 44 for broken stone. The gravel gave the cheaper, heavier and more compact concrete; with gravel the weight was 102 lbs. per cubic foot with 36 per cent. of voids, and the broken stone weighed 88 lbs. per foot with 44 per cent. of voids.

The concrete was spread in layers of about 8 ins., and well rammed with square iron rammers, weighing 25 lbs. Not more than 2 ft. were usually placed in a day, and after ramming, the concrete was protected by tarpaulins from the sun and weather and kept moist. All joints between old and new work were roughened by picking up the old surface, after which it was made wet and dusted with dry cement before the new layer was put on it.

In making 9,614 cu. yds. of concrete there were used 7,447 barrels of Portland cement, 4,382 cu. yds. of sand, 5,556 cu. yds. of gravel and 3,046 cu. yds. of broken stone. The average product of concrete was 1,241 cu. yds. per barrel of cement, and 1,116 cu. yds. per cu. yd. of gravel and broken stone. The average material for one cu. yd. of concrete was: 0.805 barrel of cement, 0.456 cu. yd. of sand, 0.579 cu. yd. of gravel, and 0.317 cu. yd. of broken stone. The cost per cubic yard of the concrete was $6.34, including materials, mixing, placing, timbering, etc., on the year's work. The cost of hand-mixed concrete, placed by derricks, and including the labor of mixing, repairs and fuel, was $1.088 per cubic yard. The concrete mixed by machine and placed by the chute was $0.555 under the same conditions. In neither of these statements does the cost of materials enter. Including materials, testing and timbering, the cost of the hand-mixed concrete was $7.152, as compared with $6.344 for the machine mixers. The cost of the sand and gravel in the bins, after washing, was $1.037 per cubic yard; and of the broken stone, $1.694 per yard.



CONCRETE PLANT AT THE CASCADE CANAL, ORE.

SEWAGE DISPOSAL OF ISOLATED DWELLINGS AND INSTITUTIONS.

The subject of the disposal of sewage from private dwellings, public institutions, etc., which are isolated and cannot be connected with any general sewerage system, is one of permanent and great importance, and we give herewith a somewhat full abstract of a paper by Mr. W. K. Parry which was read before the Institution of Civil Engineers of Ireland on April 6, 1892, and which is reprinted in the "Contract Journal," London. Mr. Parry, in his introductory remarks, stated that earth closets had not been found to afford a solution of the sewage difficulty in the country; that waste water from sculleries was quite as offensive and dangerous as sewage from a water closet; and that, as far as isolated buildings are concerned, the objections to water carriage are immeasurably less forcible than in the case of towns and villages. He quoted the experience of Mr. Paul Gerhard, of New York, on the sewerage of isolated dwellings as given in the twelfth annual report of the State Board of Health of Rhode Island for 1889, and described the three alternative ways in which sewage may be applied to land, by broad irrigation, by intermittent downward filtration, or by sub-surface irrigation. He then proceeded to give details of cases in which these methods have been practically carried out:

At the Rathdown Union, Loughlinstown, County Dublin, great difficulties had been experienced for many years in the attempts to dispose of the workhouse sewage. The pail system had been adopted some time ago instead of water closets, in order to reduce the quantity of sewage as far as practicable. The laundry water was conducted into a closed tank, from which it was pumped into a cart and carried up by horse labor to the land at the back of the building; it was here thrown into a large manure heap, where the closet pails were also emptied, and this heap was always very offensive in the summer. But the rest of the slop water had still to be disposed of, and this is just as foul and offensive as water-closet sewage. It was conducted formerly through a large stone drain into an open pond, between the river and the road, outside the walls of the workhouse. The liquid collected in this pond and percolated through the adjoining gravel pits, gradually making its way into the river. In reality the pond was nothing better than an open cesspool, which in warm weather emitted an intolerable stench. Frequent complaints were made by residents in the neighborhood and persons who had occasion to make use of the road. No public sewer existed near the workhouse into which the sewage could be conducted. The building is situated near the foot of the ground belonging to the union, which rises sharply behind it to the railway, so that any system of sewage disposal by gravitation over the land was impracticable. Several attempts were made to obtain the necessary consent for the construction of a main outfall sewer to the sea, but all these efforts were strenuously opposed by the owners of property and the commissioners of the adjoining township. Eventually the guardians decided to consult Mr. Charles P. Cotton, Chief Engineer to the Local Government Board, and Mr. Cotton recommended that the sewage should be conducted into a closed tank, and then pumped to the high land at the rear of the institution, and distributed over its surface. The guardians adopted his suggestion, and Mr. Parry was engaged to design and superintend the necessary works. In this connection it may may be mentioned that the water supply to the workhouse was obtained from a main by meter, and cost about $500 per year. To save a portion of this heavy annual expenditure the guardians considered that it would be wise to make provision for storing and utilizing the roof-water of the buildings. What is known as the "separate" system of drainage was, therefore, adopted, and two large rain-water tanks were constructed in the airing yards at the back of the institution. These tanks are 38 ft. square and 6 ft. deep, and each tank contains 52,500 gallons. The total superficial area of the roofs is 3,850 sq. yds., so that 1 in. of rainfall represents about 18,000 gallons of water. It should be mentioned that all the surface water from the yards is taken into the sewage drains, as it was considered that the risk of pollution would be too great to take it with safety into the rain-water tanks. A gravel filter is constructed at the side of each tank, by which the water is filtered on its way to the tank. The water is pumped by a steam pump into storage tanks at suitable levels, and is used in the laundry and kitchen. A reduction in the consumption of city water has been effected by the storage of the rain-water which amounts to a saving of about $250 per annum.

The sewage drains are all laid, in accordance with modern practice, on concrete with water-tight joints, in straight lines, with manholes at each change in direction. All the sewage, with the exception of that from the hospital, is conducted into two underground tanks, each 15 ft. long, 10 ft. wide, 6 ft. deep, and containing 5,525 gallons. The object of duplicating the sewage-receiving tanks is to enable one section to be cleaned out while the other is in use. Overflow pipes are taken from both sections and conducted to the under-drain from the irrigation ground. It was not thought prudent to take the hospital sewage into the tanks already described. It is, therefore, conducted into an independent tank in order that it may be disinfected when necessary, so as to prevent the spread of infectious disease. Before the sewage enters the receiving tank it is passed through strainers, so that the coarser particles and the suspended matter and other elements which are likely to choke the pumps are removed. These strainers are cleaned by the man in charge of the works. The dry weather flow of sewage is 30,000 gallons per week. It is pumped from the receiving tank four times a week by a pair of small direct-acting steam pumps fixed in one of the back yards of the main building, and delivered into the distributing tank. This distributing tank is built of concrete plastered in cement and situated above ground at the summit level of the land near the railway. It is also made with a division wall to facilitate cleaning.

When the sewage has been pumped and one section of the distributing tank is filled, a sluice is opened and the sewage is conducted, by a closed pipe carried in an embankment between the plots devoted to irrigation, to a central sluice chamber fitted with two sluices by which the liquid can be conducted to either side. The distributing pipes run right and left from the center chamber and terminate at a pair of distributing chambers, each fitted with four sluices and situated at the intersection of four of the plots devoted to irrigation. By opening any one of the eight sluices in the distributing chambers the liquid can be discharged into any one of the eight plots prepared to receive it. Each of these plots was accurately leveled, and at a depth of about 4 ft. beneath the surface a herring-bone system of agricultural drains was laid, discharging into a central main under-drain connected with an outfall drain. These under-drains are all provided with manhole chambers to facilitate inspection and cleansing, and a sluice is also fixed on the outfall drains near the distributing tank. By closing the sluice all the under-drains can be filled and flushed out, and this prevents them getting choked up. The main outfall under-drain is carried down the hill past the hospital, receiving on its way the rain-water from the hospital buildings and also from the lodge buildings. The overflows from the sewage-receiving tanks are also conducted into this main drain. It is carried along inside the workhouse grounds in the front of the buildings for some distance, and it then crosses the road and delivers into the gravel pits near the river. This arrangement insures that all the foul liquid shall be filtered through about 4 ft. of land before being discharged, and the effluent is found to be bright, clear, and free from smell. By subdividing the land into eight plots, and adopting the system of intermittent downward filtration, each of the plots receives its dose in succession, and then enjoys a long interval of rest, so that there is no fear of the land becoming sewage sick.

Part of the irrigation ground has been planted with osiers, which feed greatly upon the sewage, and flourish under the treatment. Italian rye-grass has also been grown. During 1891 between eight and nine tons of prime hay were saved, which realized about $200, and a sum of $15.25 was received for willows grown on the osier beds. In practice it is found that the quantity of land devoted to irrigation, which is about three acres, is in excess of the requirements, so that so far from the disposal of sewage being any longer a difficulty, the only matter of regret with the master of the workhouse is that there is not sewage enough for the successful cultivation of the land set apart for the purpose. It is probable that in the future the quantity of sewage will be largely increased if water-closets are substituted for the present pails, and it was with a view to this that a large area of land was laid out for irrigation. The works have now been in operation for some years and have given great satisfaction, so that not only has a glaring breach of the Public Health Act been successfully cured, but the sewage and the rain-water of the institution have been fully utilized. The fertilizing value of the former, and the saving of city water by the storage of roof-water, have combined to yield a substantial pecuniary return more than sufficient to pay working expenses. The annual consumption of coal for pumping is 20 tons, and the cost in 1891 was $110. The attendant who has charge of the works has also other duties to perform; the estimated annual proportion of his wages chargeable to the sewage account is $200. The total cost of the works was $15,100.

The second building referred to is Carton, Maynooth, County Kildare, the seat of the Duke of Leinster. The sewage of this extensive establishment formerly discharged into the lake near the house, and as the outfall was close to the carriage drive a very filthy and unsightly collection of sludge and rank coarse weeds was formed, which created a great eyesore, and one of the objects of the new system was to get rid of this accumulation. The main outfall drain of the establishment was originally a large stone culvert, about 4 ft. high by 2 ft. 6 ins. wide, and the house drains were either built of brickwork or imperfectly constructed with pipes. A complete new system of water-tight drains was laid down, those outside the building being of fireclay, and the portions under the mansion of heavy cast iron, with leaded joints. All the drains were properly trapped, intercepted, and ventilated. The original main outfall drain was utilized as a subway for the new pipe, which is laid beneath it and covered over with concrete.

A subsoil drain was also formed beneath the pipe, so that there are really three distinct systems in the culvert. The surface water in the yards passes down over the concrete bottom above the sewage-drain and with the subsoil drainage is still conducted into the lake. The outfall sewage drain delivers with a cast iron bend into an intercepting tank, plastered inside in Portland cement. A galvanized iron wire bucket is suspended under the nozzle of the quadrant metal bend, and all the sewage flows through the bucket before it passes into the chamber. All the larger suspended matter which will not pass through the wire meshes is retained in the bucket, which is lifted every day, and the contents are mixed with dry earth and removed. The chamber when full contains 380 gallons, and is provided with one of Rogers-Field's automatic flushing siphons. The outfall drain from the chamber is carried across the stream by an iron pipe, and skirts along the foot of the rising ground until it reaches the land devoted to irrigation. This site is admirably adapted to its purpose. It occupies a secluded position near the lake. It is comparatively level and consists of a porous, loamy soil, the surface being about 3 ft. above the level of the water. The distributing pipe is of earthenware and runs right and left from the central distributing chamber; it is fitted with eight sluices, from any one of which the sewage can be discharged. Iron gutters or carriers have been constructed which can be moved about from place to place, and in this way the liquid can be conducted to all parts of the irrigation ground. The land is materially benefited by the irrigation with sewage; no nuisance whatever has been created, and no practical difficulty has occurred in the working.

The objects in storing the sewage in a tank and discharging it at intervals by a siphon are threefold. In the first place, the available fall from this tank into the irrigation ground is not sufficient to secure a good velocity of discharge unless this method is adopted. Secondly, by discharging the sewage in a volume it can be readily conducted, owing to its greater volume, to any part of the land under treatment, whereas if it were allowed to dribble out through the sluices it would never reach the more distant parts of the irrigation ground. Thirdly, the land enjoys an interval of rest between each successive discharge. It must be understood that no cesspool is required in this system. The sewage tank above described is in no sense of the word a cesspool; it does not permanently retain the sewage, but discharges itself two or three times a day. In order to secure an abundant supply of water for the mansion a turbine was erected at the waterfall at the end of the lake, and the spring-water found near the lake is pumped up to a concrete tank situated at the top of the tower hill not far from the house. This tank is at a sufficient altitude to command the mansion, and fire mains are taken from it and laid all round the building. An abundant supply of water is, therefore, always at hand for all domestic purposes. A pressure gage is fixed in the steward's office, so that he can always tell the quantity of water in the tank, and give orders to turn on the turbine when necessary. By attaching the fire hose to the hydrants the sewers are periodically flushed out with clean water, and in this way they are maintained in a most perfect state of efficiency. No difficulties whatever have been experienced since the works were completed in March, 1890; and the cost, exclusive of the internal plumbing was $10,745.

At a house at Celbridge, Kildare, the sewage formerly discharged into a leaking cesspool and overflowed into a ditch. It is now conducted into a distributing tank. In this case the solids are deposited by causing the liquid to pass under and over a series of divisions in the tank. In this way the suspended matter is thrown to the bottom, and the liquid when it reaches the last section is discharged by one of Adams' automatic flushing siphons into the outfall drain. This drain is carried for a distance of 240 ft. through one of the fields near the house. The first pair of cross drains must be filled with sewage before either of the others come into operation. When the liquid rises to a certain level in the stand-pipe it overflows and passes down by gravitation to the second cross-drain, which is similarly

arranged, and thence to the third. The object of this arrangement is to secure a complete distribution of the liquid over the land, which is of a somewhat retentive character. As long as the land round the first cross-drain is able to take the liquid it continues to do so; should it become overtaxed, relief is obtained by the overflow, and the second cross-drain comes into operation. This method of distribution has been found to work very well, and it is only under exceptional circumstances that the sewage ever reaches the third cross-drain. In this instance the levels did not admit of the sewage being distributed over the surface of the land, and even the cross-drains are at a greater depth beneath the surface than the author could have wished, but it was impossible to get them up any higher without pumping. Even if the levels had permitted it, it would have been manifestly injudicious to arrange for surface irrigation in such a conspicuous position close to the dwelling. A liquid manure pump is connected with the distributing tank, so that the liquid can be pumped out of it and used for garden purposes. One advantage of this arrangement is that the distributing tank does not need daily attention, as it will collect the solids for some months before it is necessary to clean it out; but where circumstances admit it the author strongly advocates the arrangement similar to that at Carton, previously described, as the distributing tank at Celbridge, if neglected for too long a period, will not only become offensive, but the cleaning of it will be attended with considerable amount of smell, and will have to be performed at night time. It was made a condition in this case that some system should be devised which would be practically automatic, and this is the nearest approach to it that the writer could devise.

The fourth case is that of a suburban residence at Terenure, Dublin County. All the sewage of the establishment, and also that of a neighboring house, formerly discharged into an open ditch at the foot of the sloping ground upon which both houses were erected. This ditch was separated from the river by a stretch of level, sandy soil, about 200 ft. wide. The sewage lay in the ditch and caused an intolerable stench in hot weather, and, of course, any attempt to continue the drain to the river would have been checked by the sanitary authorities. Subsurface irrigation was, therefore decided upon. A new system of water-tight drains was laid down, discharging into an intercepting chamber, designed so as to retain the solids, and fitted with one of Adams' automatic flushing siphons. The special clean water feed-pipe, which is the characteristic feature of this siphon, was supplied by an independent waste pipe from a lavatory basin in the house, which was made to deliver into the feed pipe. From the outlet of the intercepting chamber the outfall drain is carried down to the low-lying land already mentioned. It is then conducted into a number of sub-surface distributing drains. As soon as the intercepting chamber fills with sewage, the entire liquid contents automatically discharge themselves and pass down into the under-drains and from thence to the soil. Between each successive discharge the land enjoys an interval of rest, during which thorough aeration takes place, and the soil is rendered fit to receive another discharge of liquid. The solids which are caught in the intercepting chamber are occasionally removed by hand. The situation of this house rendered it particularly well adapted for this method of sewage disposal, owing to its elevated position and the possession of a tract of low-lying porous soil, in a secluded position near the river, where the sub-surface irrigation beds have been laid out.

The next instance is similar in many respects to the one already described. The sewage of the establishment of a country gentleman near Oldcastle, County Meath, was formerly conducted through an old stone drain into an open dike near the river, but separated from it by a tract of comparatively level pasture land. When the writer first inspected this house very little of the sewage made its way into the ditch, as the large stone drain was choked close to the house, and the greater part of the sewage was percolating into a well under the scullery, from which water was daily pumped for household purposes. Under the new system the sewage is conducted into a large intercepting chamber situated near the old dyke, and fitted with an automatic syphon. The low-lying pasture land is laid out with sub-surface drains, which are constructed with a very slight fall, and each line of drain follows the fall of the ground, so that the average depth beneath the surface is about 12 ins. The effect of the sub-surface irrigation is very well shown. The track of each line of drain is clearly marked upon the surface of the pasture land by a bright green line of luxuriant grass, nourished, no doubt, by the liquid sewage which is supplied to its roots. Instead of a foul and stinking dike, in which a putrid, seething, and fermenting body of sewage formerly collected, there is now nothing to be seen but a field of pasture land, and there is no indication either to the sense of sight or of smell that the land in question is literally the sewage farm of the establishment. The land steward, who at first viewed the engineering operations with skepticism and suspicion, has been completely converted, and admits that the sewage problem has been satisfactorily solved.

The last work dealt with is somewhat dissimilar to the preceding ones. The owner of a house at Foxrock, near Dublin, was threatened with proceedings by the sanitary authorities for allowing the overflow from a cesspool to pass into an open ditch beside the road and thus create a nuisance. No ground was available over which the sewage could be conducted by gravitation, nor could the land between the house and the road be utilized for sewage treatment. A concrete tank was therefore formed close to the house, into which the sewage was conducted, while a separate system of clean-water drains was laid down to carry off the roof water, which is still allowed to flow into the ditch already mentioned. The sewage is lifted by means of a hot air pumping engine to a height of 20 ft., measured from the bottom of the tank to the distributing chamber formed in some meadow land at a high level at the back of the house. Here a system of subsoil distributing pipes has been laid down about 12 ins. beneath the surface, and so designed that the liquid flows equally over the entire area under treatment. The solids are deposited in the receiving tank, and are occasionally removed by hand, and the liquid is partly utilized for subsoil irrigation in the manner just indicated, and can also be pumped into a small tank in the garden and used for manuring the vines and strawberry beds. The engine is managed by the gardener.

The system has been in operation for twelve months, and the total quantity of fuel consumed in that time for the engine has been two tons of coke at $5.50 a ton, equal to $11 per annum for pumping. The sewage receiving tank is pumped out every second day, and the quantity pumped is 470 gallons. The pump is fitted with a special ball valve to make it suitable. The engine consists of a cylinder closed at one end by a steel pot, and at the other end by a piston; the steel pot is fixed within the stove, whilst the cylinder is surrounded by a water jacket. The engine is fitted with a speed governor which may be adjusted by hand, and it is kept at work by the alternate heating and cooling of the air within the cylinder, the air being caused to travel backward and forward by a loose-fitting piston within, which is worked by the engine from the outside by means of a piston rod passing through the front or driving piston. The air being used over and over again there is thus no exhaust, and there are no valves to wear out or stick fast. The furnace will burn almost any fuel, and the attention required is very simple. The writer trusts that the foregoing examples will afford sufficient evidence to show that the sewage disposal of isolated buildings presents no insuperable difficulties provided the owners are willing to go to the expense of a complete system of works.

STREET SPRINKLING IN BOSTON.

The report of the Boston Street Department for 1891 contains some very interesting matter on street sprinkling, of which the following is an abstract:

Street sprinkling in Boston has heretofore lacked system. As much money has been devoted to this purpose as could be spared by the Street Department from its street maintenance fund, and consequently the yearly expenditures have had wide variations. In the past 15 years these expenditures have ranged from $17,594 in 1877 to $104,264 in 1891, the latter sum, however, including $7,145 of the previous year's expenses.

The above figures represent only the sums paid by the city for street sprinkling, and do not take into account the amounts paid by individuals to contractors. Complaints regarding the high prices charged individuals by these contractors, prices in part rendered necessary by the fact that all property owners on a sprinkling route did not subscribe for sprinkling, led the city to extend its street sprinkling in 1891. Some of the reasons for having street sprinkling under municipal control are given in the report as follows:

1. The importance of keeping the street-surface in good sanitary condition.
2. The importance of having the amount of water used on the street under control.
3. The question of general accommodation to public traffic as far as ease and comfort are concerned.
4. The impossibility of contractors procuring complete and uniform subscriptions on a given route where the watering is done at the expense of the abutters.

In view of these and other considerations, the passage of a bill by the legislature was secured which authorized all cities with a population of more than 30,000 to annually appropriate money to water all or any streets within its limits or to assess abutters to pay for the cost of watering streets.

As Boston was unable in 1891 to appropriate sufficient money from its tax levy to water all streets needing it, and as authority to assess abutters was not given early enough, most of the streets sprinkled by the city were in the suburbs or were the main thoroughfares leading to them. Paved streets and those in thickly settled parts of the city where the residents could well afford to meet the cost were left for private sprinkling. A plan has been formulated by which all the expense of street watering save administration will be assessed upon abutters.

During 1891, out of a total of 434.59 miles of streets, there were watered 282.93 miles. Of this length 151.86 miles, or about 2,000,000 sq. yds., were watered by the city directly, and 131.07 miles, or about 2,692,000 sq. yds., by contractors, the city paying for part of the latter mileage, abutters for part, and city and abutters jointly for some of it.

The cost per mile per year of the watering done by the city was $332; by contract, $312.44, both exclusive of supervision. The entire cost per 1,000 sq. yds. to the city, except for water, of watering done by itself was $23.17; for contract work the city paid $16.38 per 1,000 sq. yds. The contractors collected an unknown amount from private consumers, which may partially account for their being able to do the work cheaper than the city.

The city owned 6 carts and hired 55; the contractors used 91 carts, thus making a total of 152 carts used. Some of these carts were quite large, so that the total number would be equal to 165 carts, with a capacity of 600 gallons each, or 1.7 of this sized carts per mile of street watered. The streets were watered from two to four times a day in dry weather, and the total cost, as has been stated, was $104,264, but this included $7,145 paid for water used in 1890. The amount paid for water used in 1891 was $7,200. The cost for water per square yard sprinkled cannot be given, as the figures include, we suppose, only what the city paid and not what the contractors paid. At the close of the year there were 271 water-posts for filling carts.

It is estimated that each cart should cover from 27,000 to 30,000 lin. ft. of spread per day.

The estimates of expenses necessary for street watering this year aggregate $250,000, and are based on the following assumptions: Watering is necessary for eight months in the year and on 368 of the 434 miles of streets. There are approximately 206 miles of streets 40 ft. wide or less, or 47½ per cent. of the total mileage; 206 miles more than 40 and less than 66 ft. wide, or 47½ per cent. of the total; 22 miles more than 66 ft. wide, or 5 per cent. of the total. The first-class requires one, the second two and the third three spreads. Of the streets 40 ft. wide and less 66 do not need watering on account of isolation, shade or other considerations. This leaves 140 miles of the first class which require a single spread. For streets with one spread 65 carts are required; for two, 130 carts; for three or more spreads, 22 carts. This makes a total of 220 carts, which, at $1,050 per year, would cost $231,000. Add to this $12,000 for supervision and the expense of assessing the cost upon abutters and $7,000 for water, and there results a total of $250,000 necessary for sprinkling 368 miles of streets of all widths, or an average of about $680 per mile. This is acknowledged as a high figure and one which can be reduced with more perfect organization and the lower prices which will result from competition.

THE RENMARK IRRIGATION COLONY, SOUTH AUSTRALIA.

The last report of the Public Works Department of South Australia contains an interesting account of the progress being made by Messrs. Chaffey with an irrigation colony at Renmark, on the Murray River, located, it appears, on land granted them by the government.

The area of the grant is not stated, but in May, 1891, the proprietors had sold 2,200 acres, and had an additional area of 6,200 acres surveyed. A continuous "vermin-proof" fence, 30 miles long, surrounds a section or the whole of the grant.

The land has been divided into township, villa and horticultural areas. The township area comprises about 200 acres, divided into lots with a gen-

eral size of 33 ft. frontage by 155 ft. depth, and with a river site reserved for government offices. Three main streets, each 198 ft. wide, intersect the town, and the other streets are 99 ft. wide. About half of the lots have been sold, and many private and public buildings have been erected. The population in the whole colony was estimated in June, 1891, as 600.

The villa area comprises some 320 acres, divided into 2½-acre plots.

The horticultural area occupies the rest of the grant and is divided into 10-acre plots, with provisions for water at the highest point of each, and with a system of streets and avenues.

At the time of the report 17½ miles of irrigation canals had been constructed, four miles of which had been concreted. Of the total length of canals 9½ miles were main and 8 miles subsidiary channels. Several miles of additional canals were under construction or had been surveyed.

There were, at the time of the report, four pumping stations at the colony. The three for irrigation had a combined capacity of 31,680,000 imperial or 38,016,000 U. S. gallons. Two of the stations are located at different points on the Renmark reservoir, and one draws water directly from the Murray River. For the supply of the township there is a pumping station on the wharf at the river with daily capacity of 2,040,000 imperial or 2,548,000 U. S. gallons.

Arrangements had been made at the time of the report for a second grant to Messrs. Chaffey, consisting of 4,580 acres, and surveys for still another grant of 4,000 acres were being made. The second grant was already partly occupied by settlers, and five miles of irrigation canals were under construction.

It should be added that the grant to Chaffey Bros. provided that they should build or suitably endow an agricultural college for the technical instruction of the settlers, and that arrangements were being made to carry out this provision. It should also be added that there is a similar but larger irrigation colony at Mildura, Victoria, also under control of gentlemen named the Chaffey Bros., and probably the same as the proprietors of the Renmark Colony. The Mildura colony is described in appendices to the 1889-90 and 1890-91 reports of the Victoria Water Supply Department.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Damages for Construction of Tracks.

Damages can be recovered for injuries sustained from the existence and operation of a railway, switches and coal bins in close proximity to one's lot, although they do not occupy the street upon which the lot abuts, nor disturb ingress or egress to and from the same. In an action to recover damages there is no error in an instruction that, if the property is "rendered less valuable" by the construction and operation of such road, etc., the jury shall find for the plaintiff, when they have already been instructed that he cannot recover for injury "suffered in common with the public at large." (Ft. Worth & R. G. Ry. Co. vs. Downie; Supr. Crt., Tex., 17, S. W. Rep., 620.)

PERSONALS.

Mr. R. A. Bryan has been appointed City Engineer of Portsmouth, O.

Mr. James Conway, railway and bridge contractor, died at Boston, Mass., May 25.

Mr. James Clayton, of the Clayton Air Compressor Works, New York, sailed for Liverpool on the "Aurania," May 28.

Mr. Frank McKeon has been appointed assistant engineer in charge of the sewers now being built at Lansinburg, N. Y.

Mr. James W. Fillmore, Manager of the Pacific Coast Ry., died at San Luis Obispo, Cal., May 21. He was born at Scranton, Pa., 42 years ago, and had been for several years connected with Western railways.

Mr. Samuel Rea has been appointed Assistant to the President of the Pennsylvania R. R. He was connected with the road for some years and resigned in 1890 to take the position of Vice-President and Chief Engineer of the Maryland Construction Co., which built the Baltimore Belt R. R., and has lately been in business in Pittsburg, Pa.

Mr. Geo. H. Thomson, Engineer of Bridges of the New York Central & Hudson River R. R., was injured in a collision on that road, May 23, having his arm broken, and being badly bruised. He was riding with Mr. W. D. Ottis, General Roadmaster, on the latter's special inspection engine, following a southbound train from Poughkeepsie, N. Y. Near Clinton Point an engine ran out from a sidetrack after the train had passed, and was run into by the inspection engine.

NEW PUBLICATIONS.

SAFE BUILDING.—A Treatise giving in the Simplest Forms possible the Practical and Theoretical Rules and Formulas used in the Construction of Buildings. By Louis De Coppet Berg, F. A. I. A., M. Am. Soc. C. E.; Vol. II. Boston: Ticknor & Co. 8vo., pp. 280; 62 tables, 289 cuts, 43 plates; $5.

The first volume of this work (which, so far as then appeared, was all of it,) we reviewed in our issue of Dec. 28, 1889. The second volume is wholly confined to the details of iron-work design for buildings, the unexplained omission of which from the first volume we noted in our former review. We are pleased to note also that a very good index to both volumes accompanies this one, supplying (in part) an extraordinary omission of the first volume. To fully supply it, however, the index to both volumes should be inserted in both volumes in all future editions. It is almost as troublesome to have to pick up another volume to refer to an index as not to have any.

An irritating defect of this work, for which the publisher is responsible, is its needless bulk. The tendency of our American publishers of technical books to ponderosity seems to be incurable, and certainly it is a temptation to add a pound or two of needless paper at 10 cts. per lb. if it makes it seem more reasonable to charge a stiff price for a really small book. The average buyer judges by bulk, doubtless, rather than by the quantity of reading, as to whether he is getting his money's worth or not; but it is certainly padding a book for practical use most unreasonably to use 54 sq. ins. of page to hold 21 sq. ins. of text, as is done in this one. The sensible buyer would much rather pay a dollar extra to get these two volumes printed in one, on paper of reasonable thickness only, and on a page of not over 35 sq. in. This would bring the work down to about one-eighth of its present weight, without changing the type, which is very suitable and clear. We could wish also (to speak of another side issue) that architects would reserve their fearful and wonderful style of lettering and numbering for their working drawings, and keep it out of books; but this is too much to ask.

Coming down to the merits of the contents of the volume, we are glad to be able to speak more favorably of it than of the first volume. It is, undoubtedly, the best architectural work on the subject which exists. It is almost exempt from the charge of sketchiness, which we brought against the first volume, and so far as we have detected, it is a really good treatise, so far as it goes, on architectural iron work for the use of architects or architectural engineers. It does not go far enough, but it certainly has a good many strong points. It opens with 55 pages on the "Nature and Uses of Iron and Steel," included in which is one of the best practical articles which we have seen anywhere on cast iron and the various qualities thereof. There is a plentiful lack of this same information in some engineering works which ought to have it. The brief paragraph on steel castings is hardly up to date. As yet they are little used in architectural work, but there is quite a field for them there as subsititutes for special forms of wrought iron, and it is misleading and inaccurate to class them in with iron castings.

We note also, on page 18, what we believe to be an inaccurate statement in regard to malleable iron, viz.: that it is only practicable to render the outer skin malleable to a depth of ¼ in., the interior (if thicker than ½ in.) "retaining its unaltered cast iron character." We understand this statement to be quite erroneous, and to have its origin only in a common impression, due to an ocular deception when malleable castings are broken. They then look as if only the outer skin had been affected, but we understand that the effects of the process really extend quite uniformly through the entire mass, even if several inches thick, provided the casting has been properly treated.

The next two chapters (80 pages) on riveting and plate girder designing, are also very good, and to the point, though in a sense somewhat "sketchy." An example of designing a large girder is worked out in detail, very clearly and well. To thoroughly master the subject of these chapters and the next one (on graphic statics) it would be better to study them in the more elaborate engineering works on the same subject, but to any one with only immediate practical work in view these chapters may be more helpful, as they are written in simpler and less technical language than the ordinary engineering text book, and from a strictly architectural standpoint.

The next and concluding chapters (except for the tables) are on the design and detailing of roof trusses, and of columns. So far as they go, these chapters also are very clear and unexceptionable, but they hardly go as far as they should in respect to that all-important matter, the design of details and of detail connections.

An omission which is rather surprising, is all discussion of steel foundations, and the general doubt cannot but occur, in reading over such a treatise as this, whether it is really expedient or proper for architects to pretend to design the complicated iron work of large modern buildings, or whether it is really useful to write books to aid them to do so. A few architects, like the author of this volume, have the necessary substratum of technical training for doing so, but in the main, the design of the iron work of large buildings is getting to be a profession of itself. It certainly has a much closer relation to engineering than to architecture, and it hardly seems worth while to aid or encourage architects in an attempt to half-master a new art which has so little relation to their own special field. There have been a few Michel Angelos in the world's history who were great in architecture, engineering, painting and sculpture at once, but such gifted beings are scarce in modern times, and as a rule, which will have few exceptions, the good architect will be a poor engineer, and cannot make himself anything else, and the good engineer a poor architect. This results from the very nature of the two professions. Architecture is primarily an artistic profession; engineering, utilitarian and constructive. The two are even antagonistic to each other, so that, as a man's skill grows greater in one direction, it is likely to grow weaker in the other. Architects are continually committing astounding and ridiculous errors in "safe" building, and no one, nor twenty, books will save them from it, just as engineers are continually committing astounding and needless errors in artistic effects, because they will insist on disregarding or trusting to their own ideas of good art, rather than ask the advice of an expert in design. Some words of caution to architects as to the danger of dabbling in what they do not thoroughly understand and are not necessarily expected to understand, would at least have been appropriate in this volume.

VALVE GEARS FOR STEAM ENGINES, by Cecil H. Peabody, Associate Professor of Steam Engineering at the Massachusetts Institute of Technology. New York, John Wiley & Sons, 8vo., cloth, pp. 128, 25 plates, $2.50.

The author intends this book for the use of engineering students, and his rather free use of mathematical discussion will probably tend to limit its use outside of the class room. The six chapters are devoted respectively to the plain slide valve, shifting eccentrics, link motions, radial valve gears, double valve gears and drop cut-off valve gears. A serious defect is the grouping of all the cuts on folding plates at the end of the book and it is a wholly needless one since none of the illustrations are too large for the printed page. There appears to be no end to the multiplication of text books on this and some other like special subjects, for very slight apparent reasons in the way of shedding new light on their subject. We must be forgiven for feeling that it is being carried too far.

WROUGHT IRON AND STEEL IN CONSTRUCTION.—Convenient Rules, Formulas and Tables for the Strength of Wrought Iron and Steel Shapes used as Beams, Struts, Shafts, etc., made by the Pencoyd Iron Works. A. and P. Roberts & Co., Philadelphia, Pa.: Jas. Christie, Editor; 8th Ed., 1892. 12mo. pp. 267 and 43 plates.

This eighth edition has been revised and enlarged throughout, in recognition of the great changes in practice which have occurred since the first edition was compiled in 1884. The tables have nearly all been enlarged to cover steel as well as iron, and there are new articles on buckle plates, corrugated flooring, Z-bar columns, and various other constructive details which have recently come into prominence, including full tables of the safe load of various shapes used as struts. The pocket book is strictly restricted to shapes rolled or produced at the works, but covers very completely all details likely to be required in regard to these. We judge it to have been very carefully compiled and edited, and to be a useful addition to the series of valuable works of this nature which have been issued.

STATISTICS OF THE AMERICAN AND FOREIGN IRON TRADES FOR 1891.—Annual Statistical Report of the American Iron and Steel Association, Philadelphia. 8vo, pp. 83.

This valuable report contains complete statistics of the American iron trade for 1891 and preceding years, and a brief review of its present condition: also the latest statistics of the iron and steel industries of foreign countries. We give in another column a somewhat lengthy abstract of the main features of the report.

REPORT OF THE RAILROAD AND WAREHOUSE COMMISSION OF THE STATE OF MINNESOTA, for the Year ending June 30, 1891. Pub. Doc., pamph., 8vo., pp. 676.

The greater part of this report is taken up with the reports of the railway companies and of the several grain inspection and weighing departments. There is very little of technical interest.

TRADE PUBLICATIONS.

GRAPHITE PRODUCTIONS. Jos. Dixon Crucible Co., Jersey City, N. J. 8vo., pp. 40.

This is an illustrated catalogue and price list of the

company's graphite productions, including lubricators, graphite grease, paint, crucibles, core wash, pencils, etc.

HOISTING AND CONVEYING PLANT.—Lidgerwood Mfg. Co., New York. 1892. 8vo., pp. 40.

This pamphlet contains sketches of the company's hoisting and conveying devices employed in open pit mining, quarrying and construction work. It shows various applications of the suspension cableways, and descriptions of the plant.

SOCIETY PROCEEDINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The date for the summer convention at Plattsburg, N. Y., has been changed from June 21 to June 28. Headquarters will be at the Hotel Champlain, at Bluff Point, three miles south of Plattsburg. Rates to members and guests have been reduced to $3.50 per day. The first session for the reading of papers will be held on Tuesday evening, June 28; among the special subjects to be discussed are the crushing and granulation of ores and magnetic concentration. Excursions are to be arranged to Port Henry, Crown Point, Mineville and Lyon Mountain, with a trip into the Adirondack wilderness. Mr. A. L. Inman, of Plattsburg, is Chairman of the local committee of arrangements.

NEW YORK RAILROAD CLUB.—At the April meeting the subject of lost defect cards was discussed, and it was stated that many cards are removed from cars when no repairs are made and, on the contrary, many cars are repaired and the card is left on the car.

The subject of leaky flues in locomotive boilers was brought up, and Mr. West said that the New York, Ontario & Western locomotives, which were giving much trouble a while ago, had been much improved by the introduction of a dead plate, covering up about 20 ins. of the grates at the front of the firebox. With grates in the front end the fire is apt to get thin or dead, and allow a current of cold air to strike the flue sheet. Mr. Mitchell said that a similar plate 14½ ins. wide had been in use on the Lehigh Valley for several years; and if the plate was moved back from the flue sheet a little, engineers would report it as quickly as they would a hot journal. He also said that some of the Lehigh Valley engines burn either anthracite or bituminous coal. They run west with hard coal and come east with soft. Nearly every engine is fitted with shaking grates.

President Blackall described a method of stopping sparks as follows:

We took a locomotive from our shops with the gasket under the exhaust pipe blown out about 1½ ins., and when the pipes were put back a new gasket was put in. The engineer complained right away that something had been done to his engine, for it did not steam as well. There had been nothing done except new gasket applied. It gave us a thought, to drill two ⅜-in. holes directly in near the bottom about 6 ins. from the top of the joint, directly in the front of each exhaust pipe, and we certainly had very good results from it. It does not injure the steaming qualities of the locomotive, and it does deaden the sparks.

The discussion then turned on roller bearings. Mr. Adams said that one car fitted with Meneely roller bearings had been running for three or four months on the Boston & Albany. The weight is about 11,000 lbs. per journal. At first the rollers crushed, but they were renewed, and the car has since run very successfully. A ball bearing journal was also tried on the Boston & Albany, but proved a failure. President Blackall said that three cars with the Meneely bearing were running on the Delaware & Hudson on fast trains and doing excellent service. The bearings are also in use on the Albany electric cars.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The party from the East, which arrived at San Francisco to hold the summer meeting of the Society on May 16, numbered about 75. The headquarters were established at the Palace Hotel and professional sessions were held in the Academy of Sciences hall. The visitors were formally welcomed in speeches by Mayor Sanderson, Dr. Harkness, President of the Academy of Sciences, and John Richards, President of the Technical Society of the Pacific Coast.

The first session was held on Monday evening, and the papers on "A Problem in Water Power," reprinted last week, and on "Self-Lubricating Fiber-Graphite for Bearings," "A Novel Fly Wheel," and "An Experiment with Aluminum," abstracted two weeks ago, were read. A paper on "Machine Molding," by Harris Tabor, of Elizabeth, N. J., was also presented. On Tuesday the day was spent in an excursion around the bay, visiting the Mare Island Navy Yard and other points of interest. At the evening session eight papers were read, one by Albert W. Stahl, U. S. N., on "The Utilization of Wave Power," exciting extended discussion. We abstract this paper on another page.

On Wednesday the whole day was spent in an excursion to the Crystal Springs reservoir of the Spring Valley Water Co. At San Mateo the party left the train and were taken by carriages to the dam and reservoir under the escort of Messrs. Chas. Webb Howard, President, and Herman Schussler, Chief Engineer of the Spring Valley Water Co. (The San Mateo dam was illustrated and described in Engineering News of March 2, 1889.) After the return to the city, an evening session was held at which the remaining papers were read and discussed, including, besides those already abstracted or reprinted in these columns, a report of the Committee on Standard Pipe Flanges. Thursday morning was spent by the members of the Society as the guests of Adolph Sutro at Sutro Heights. In the afternoon visits were paid to the Union Iron Works, the Pacific Rolling Mills, and other manufacturing plants. At the Academy of Sciences in the evening a lantern slide illustration of notable machinery in use on the Pacific coast was given by the California Camera Club; afterward a reception was tendered to the members by Mrs. A. S. Hallidie.

This concluded the regular program of the meeting. Friday was spent chiefly in visiting Oakland, Berkeley, the University of California, and points of interest in the city. On the following day the party broke up, some going to Yosemite and other points of interest in the state, others starting homeward by various routes. A few of the members will take a trip to Alaska before returning.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—On Wednesday, June 1, the papers for the evening will be on "Wind Bracing in High Buildings," by Henry H. Quimby, and "A New Formula for the Strength of Columns," by Prof. A. J. Du Bois. The abstracts of these papers, issued by the Secretary, which, by the new rules of the Society, are the only abstracts which can be made, either of the papers or discussions, until published in full in the Society "Transactions."

Mr. Quimby's paper on "Wind Bracing in High Buildings" points out the wide variation of practice among architects, and show that ideas differ not only in regard to details, but as to the amount and operation of the forces to be resisted. There is a substantial agreement among engineers as to the design of metal structures, the greatest differences being as to the use of cast iron, and the relative merits of hollow tile walls and of iron or steel rods as vertical bracing. Some architects depend for lateral stability wholly on ordinary partitions, no matter how much weakened by openings. The greatest difficulties arise in cases of yielding foundations. The idea that the exterior walls are a mere exterior curtain to shield the interior metal frame is correct, if this interior frame be efficiently braced, but not otherwise. A building 200 ft. high and 60 ft. wide is mentioned in which the rear wall is 13 ins. thick and is but little else than a grand window frame. The front from the 3d to the 15th floor is of the same thickness, and has two bay windows, which, owing to their curved form, can offer little lateral resistance. The vertical bracing consists of interior partitions made of hollow tiling, the united thickness of the webs being 2¼ ins. An illustration is given of the connections between the vertical and horizontal members of the iron framing, showing their inherent weakness to resist deformation by a lateral force. The action of such a force is discussed, also the wind pressure against which it is desirable to provide. The question of imperfect workmanship as affecting stability, as also that of vibrations due to cars, trucks and electric dynamos, is considered; also the possible occurence of earthquakes, with the best method of guarding against them, and the great danger from deficiency of wind bracing to which many buildings used for manufacturing purposes are exposed by reason of large floor areas without partitions, and from the regular vibrations of machinery.

Prof. Du Bois' paper on "Strength of Columns" gives a formula which is claimed to be more accurate and to possess a wider scope than those in common use. It is based upon the length and cross-section of the column, its physical characteristics, and the end conditions. The discussion is theoretical, and results in the establishment of three formulas, respectively for long, intermediate and short columns. The first and third when plotted give curves, and the second, a straight line. The constants in these are: the breaking unit stress in the outer fiber from compression, the modulus of elasticity, and one depending on the end conditions. The remainder of the paper is taken up by a comparison of results from well known experiments with those given by the formulas.

At the meeting held May 4, the paper on "Tunnel Alinement" was discussed by Mr. R. B. Stanton, M. Am. Soc. C. E., who mentioned one difficulty of alinement which arose from a bulging upward of the bottom. Mr. O. F. Nichols spoke of the desirability of a better light for such work than the old oil lamp. He described the work of alineing a Peruvian tunnel, which was done principally by miners on account of illness of the engineer. The headings met within 2 or 3 ft. He criticised the great amount of instrumental work done, as he considered the refinements often used unnecessary, and mentioned rough methods used to guide the workmen. Mr. J. F. O'Rourke described the method adopted in the Haverstraw tunnel, using reference plugs in the roof for both line and grade. Mr. J. Foster Crowell approved of keeping the line of sight of the level and transit out of reach of the work, and mentioned the use of a diamond drill for testing the position of the center line from the surface above; a string being stretched taut through the hole, and its departure from a vertical calculated. Mr. A. McC. Parker described the transfer of a line down an inclined shaft, the axis of which was twisted during its excavation. The secretary called attention to the wide range of usefulness of templates (as mentioned in the paper) for locating accurately bearing stones, etc., without the use of level or transit, so that the presence of an engineer is not required.

Annual Convention at Fortress Monroe, June 8.—Additional papers will be presented at the Convention as follows: "Tests of the Power Required to Drive Electric Street Cars, and the Total Efficiency of the Motor," by Mr. L. B. Bonnett, "Thin Floors for Bridges," by Mr. A. F. Robinson.

The following abstracts of papers to read at the Convention have been issued by the Secretary, and under the new rules of the Society are the only ones which can appear prior to the publication of the papers in the Society's "Transactions:" "The Black Eagle Falls Dam, Great Falls, Mont." by Maurice S. Parker, M. Am. Soc. C. E. The author presents a small map, a facsimile of that made in 1805 by the explorers, Lewis and Clarke, to accompany their report, which shows the Missouri River at the Falls. From the first rapid to the foot of the Falls, a distance of 10 miles, the descent is 412½ ft., and 75½ ft. of this is a "sheer drop" at the Great Falls. The minimum flow of the stream is 4,000 cu. ft. per second, except when the flow is affected by "anchor ice dams," which are described by the author. The dam described in the paper is built just above Black Eagle Falls and gives a 40-ft. head of water for power. It was completed in 1891, and full details of bids for doing the work (all of which were rejected and the dam built by day's work), cost of labor and methods of construction, are given. The dam is built of timber cribs filled with stone partly laid in cement, and the chief difficulty to be overcome was the rapid current, due to a fall of about 2% at the site. The cost of construction is given in detail, the total being $175,000. Assuming 3,360 cu. ft. as the minimum flow, there would be available 12,287 HP., and the cost would therefore be $13.19 per HP.

"Hardening Structural Seeel," by A. C. Cunningham, M. Am. Soc. C. E. The author, after mentioning the dearth of information on the subject of hardening steel eyebars, describes the present method of making the head, and states that the upsetting, hammering and partial heating of the bar, leave the steel in an uncertain condition as to internal stress. This can only be removed by thorough annealing. Two tables of tests of specimens from bars, one annealed and the other not, are given, which show the improvement caused by annealing, in stretch reduction of area at point of fracture, and appearance of fracture. In full sized bars there is a loss of ultimate strength of 2,000 to 6,000 lbs. per sq. in. from annealing, which if not allowed for in the specifications is an annoyance to both engineers and manufacturers.

Tables are also given of tests of bars heated to a cherry red heat, and variously quenched in water, fish oil, soap and water, and boiling water. Those in oil give excellent fractures, low stretch and high reduction, indicating a material combining toughness and rigidity. The author says that these specimen tests seem to indicate that with perfect control of the conditions, any desired result may be obtained. He also suggests a method of testing for obtaining more definite results, as follows: "A plate to be rolled of such dimensions that it may be slotted into two eyebar flats, and also give a sufficient number of specimen tests to show the condition of the steel at all points. The two flats to be made into eyebars, one finished by the annealing method and the other hardened, and both tested for comparison." The author states that the application of hardening steel in compression members is fully as important as it is in eyebars, and discusses it briefly.

"The Results Obtained from Tests of Full Sized Steel Eyebars," by Frederick H. Lewis, Esq. The author found differences as great as 5,000 to 10,000 lbs. per sq. in. between the tested strength of full sized steel eyebars and of small specimen tests of the same material, together with a notable decrease in the full sized bars in elastic limit. Table No. 1 gives tests of bars varying in size from 4 × 1¼ ins. to 8 × 2 7-16 ins. compared with test specimens from each, which show that such losses are the rule and not the exception, as these tests were not specially prepared. The study of this table led to the preparation of test specimens cut from the identical bars which were afterward tested as eyebars. In tables 2 and 3 are given the results of 35 such

comparative tests, showing elastic limit, ultimate strength, stretch, and reduction in area. The average loss in elastic limit is 1,142 lbs., and ultimate strength, 3,595 lbs. The reduction in area is somewhat greater in the specimen tests; and the stretch in 8 ins. as compared with that on the gage length of the bars, was nearly double. Table No. 4 gives tests of annealed specimens compared with the previous tests of the specimen in natural state and of the full size bars.

The author comments on the irregularities in the tests for elastic limit, which make it impossible to put them in a line or curve. He shows, however, that large losses occur generally in bars giving high specimen tests, but that bars of 60,000 to 64,000 lbs. ultimate strength show average losses of 765 lbs. per sq. in. Other comparisons are made. His conclusions are, first, that we have only to use steel with tensile strength and the large losses will disappear. Second, that tests which give high figures in specimen tests are less liable than those which give low ones, and do not represent the mean value of the material. Engineers are deceived by these high values and no doubt the real quality of any material is shown by the mean results.

The paper next treats of the losses in elastic limit and ultimate strength by annealing, the effect being chiefly in softening the outer skin. These losses are, however, legitimate, and should be provided for in the specifications. The third element in these losses, the "bad one," as it is called, is due to the fact that the rupture in a specimen takes place at the weakest point, and shows the loss of uniformity in a bar. Bars with hard and soft zones ought to be excluded from a work. This irregularity is shown to be greatest in bars with high elastic limit; hence this limit becomes an excellent criterion of quality. This matter is treated at some length; and the paper concludes with some practical considerations as to the bearing of the facts on the relations between the engineer and the manufacturer, or in other words, what shall the requirements of a specification be in order to obtain eyebars of the greatest available strength, and in the best condition for use.

"Emergencies on Railroads," by Channing M. Bolton, M. Am. Soc. C. E. This paper is confined to three topics: first, the removal of a wreck on an ordinary cut or fill when the track is obstructed; second, the removal of a wreck occasioned by the fall of a bridge; third, a list of tools, material, and other things which every railroad company should have at a convenient point on the line, ready for use when emergencies arise. The paper deals with the arrangement and disposition of the repairing forces, the proper methods of removing wreckage, and of erecting false work, or trestles for temporary track where it is needed.

"Experiments on Iron and Steel Joints on an Angle," by Bertram B. Flint, Esq. This paper details the results of certain experiments made on lattice bars of various dimensions, riveted in various ways to a $6 \times \frac{1}{2}$ in. iron plate. The breaking load varied between the limits of 45,800 to 55,660 lbs. per sq. in. of net section. In some cases the rivets sheared, in others the plate broke between rivet holes. The specimens with reamed holes were in general the stronger. The strength per square inch of the lattice bar increased as the angle made by the line of rivets with the bar increased. The strength of the joint as a whole for the same number of rivets was but little affected by the position of the holes.

"Rainfall, Flow of Streams and Storage," by Desmond Fitz-Gerald, M. Am. Soc. C. E. This paper is founded on, and descriptive of, 15 tables which were prepared for the purpose of calculating the yield of drainage areas which have varying proportions of land and water surface, and are as follows: No. 1. The monthly rainfall at Boston for 74 years from 1818 to 1891, inclusive. No. 2. The monthly rainfall on the Sudbury water-shed for 16 years. No. 3. Yield of the Sudbury water-shed in inches of depth during the same period. No. 4. The percentage of the rainfall collected on the Sudbury for that period. No. 5. The evaporation from the water surface in 16 years. Nos. 6, 7, 8 and 9. The yield of the Sudbury water-shed in millions of gallons; in cubic feet per second; in millions of gallons per square mile, and in cubic feet per second per square mile, in 16 years. No. 10. Calculated yield of this water-shed on the basis of the land surface in millions of gallons for 16 years. No. 12. Same as No. 11, in cubic feet per second. No. 15. The average yield of the three water-sheds, the Cochituate for 28 years, the Sudbury for 16 years, and the Mystic for 16 years, in millions of gallons per square mile. In addition to these tables there is also given a table and diagram showing the storage capacity required to sustain drafts of 100,000 to 900,000 gallons daily from one square mile of water-shed, containing various percentages of water surface. This table is based on the greatest droughts occurring on the Sudbury River during the 16 years from 1875-90, and shows that a daily draft of 600,000 gallons per square mile is as great as can be depended on, no matter what the extent of the storage may be. With a draft of 900,000 gallons per day, a basin on the Sudbury water-shed would have been kept below its flow line for 9 years of the 16 of which records are given.

The paper first takes up the general subject of rainfall, and gives the yearly means at Boston of 47 ins. for 74 years, at Lake Cochituate of 47.98 ins. for 40 years, and of the Sudbury River of 48.80 ins. for 16 years. Maximum and minimum annual rainfall are next treated. The annual range at Boston is from 27.70 to 67.73 ins. The minimum monthly rainfall was 0.23 in. and the maximum 12 ins. A diagram shows the months of March, August and November to give maximum, and June and September minimum rainfalls.

From 45 to 50% of the rainfall flows away in the streams, and about 50% is evaporated from the ground and other surfaces. From water surfaces near Boston about 82% is evaporated. A new evaporation curve is given, followed by a description of the water-sheds and the distribution of the flow of the stream. A table is given by the yield of a typical New England water-shed, followed by a diagram of the mean monthly yields of the Sudbury, Cochituate and Mystic sheds, and another of the average monthly yield per square mile, arranged by months, in the order of their magnitude. The maximum monthly yield from the Sudbury water-shed was 7.448 cu. ft. per second per square mile or about 100 times the minimum monthly yield. The maximum for 24 hours was 41.4 cu. ft. per second per square mile. The minimum monthly yield was 0.065 second feet per square mile. The average daily yield was 1.5472 second-feet per square mile.

"Uniform Practice in Pile Driving," by J. Foster Crowell, M. Am. Soc. C. E. Mr. Crowell refers to the authors who have given the formulas now best known as to the bearing power of piles, and gives a diagram illustrating the variation in a particular case of the results given by 16 formulas both as to extreme sustaining power and permissible load. These variations arise from the different methods of treating the problem, some authors taking into consideration the compressibility and weight of pile, others neglect one or both. It is not considered worth while to refine a result beyond the refinement of the data.

The Trautwine formula being based on the cube root of the fall, is criticised as probably giving too great an allowance for the resistances to the fall of the ram, and as not being quickly applicable to individual piles. The formula for this purpose should depend on weight and fall of the ram and the penetration of the pile at the last blow. A comparison of the Weisbach (or Sanders), Trautwine, and Engineering News formulas is made and the results plotted in curves, resulting in favor of the latter; the form of which is given

$$L = \frac{2\ wh}{s + c},$$

(The actual formula was

$$\text{Safe load} = \frac{2\ wh}{s + 1},$$

in which w=weight of hammer in any unit (the safe load being given in the same unit); h=weight of fall in feet, and s=last pentration in inches, assumed to have been reasonably uniform for several chords.)

The author's change in this consists in making the constant (c) a "tangible variable for natural conditions and a selective variable according to the requirements of the case." Three cases are considered:

1. Where the load is static and known, but the natural support for the piles is insecure and doubtful.

2. Where the support is reliable, but the load is dynamic.

3. Where the support is not known and the load is dynamic.

A 2,000-lb. ram falling 20 ft. on a 12-in. pile is taken as the standard; (c) is then taken equal to 0.1 + n, and n is made in each case equal to half the square root of the maximum penetration of the pile under a blow of 40,000 ft.-lbs. or more, and values of n are tabulated.

For the second and third cases the formula takes the form

$$L = \frac{2\ wh}{s + .1 + n \times n'},$$

in which n' is an abitrary variable dependent on the duty the pile is to perform. A list of values of n' is given for various uses, also of n' and s'. The great difference in practice regarding the use of piles is mentioned, and the fact is clearly stated that too many piles may be used, so as to overload the bearing strata. Working factors of safety are also given.

"The Cantilever Highway Bridge at Cincinnati," by Gustave Kaufman, M. Am. Soc. C. E., and "The Cantilever Span of the Dam," by F. C. Osborn, M. Am. Soc. C. E. This bridge was built during 1890 and 1891. Its total length is 2,966 ft. and the main cantilever span is 520 ft. between centers of piers. The roadway is 24 ft. wide, and there are two sidewalks, each of 7 ft. width. The channel span has a clear height of 100 ft. above low water, and 40 ft. above high water. The site was very favorable for building upon, as rock foundation was found at very moderate depths. The work was greatly impeded by the great number of floods of those years. Details of quantities are given, and two valuable tables of the exact quantities of each kind of stone used in the piers, and the contents of the joints. Specifications for all work are given in the appendix, to which reference is made for much of the detail. A number of the drawings and plates are given in illustration.

Mr. Osborn writes of the special treatment given the cantilever span, the intention being to "eliminate, as far as possible, all undulatory and vibratory motion from passing loads;" riveted connections being for this reason made large use of. The question of appearance as affecting the design was considered, and the elements governing the calculation of camber are given. The anchorage strain was calculated at 136,000 lbs. for each truss, and is taken up by a $6 \times 1\frac{1}{2}$-in. eyebar anchored in 20 ft. of masonry. Provisions were also made for alternating strains in the top chord of the anchorage arm.

"Bridging Canyons Lengthwise," by Howard V. Hinckley, M. Am. Soc. C. E. This is a description of the peculiar features of two bridges. The first is in the Apache Canyon of the Rio Galisteo, on the main line of the New Mexico & Southern Pacific R. R., and sections and plan of the river crossings are given, also a plan and elevation of the bridge. The center line is on a 10° curve, and is 14½ ins. off the center line of the bridge at the ends and center. The second case is in the Royal Gorge of the Arkansas River, and is known as the "hanging bridge." A view and end elevation are given. The great peculiarity is the suspension of one of the trusses from the intersections of pairs of inclined beams which rise from abutments against the rocks on opposite sides of the canyon to the point of intersection, where they abut against each other.

COMING TECHNICAL MEETINGS.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
June 2. Secy., T. G. Philfeldt, 113 Adams St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
June 2. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.

NEW YORK RAILROAD CLUB.
June 2. At 12 W. 31st St. Secy., H. G. Prout, 73 Broadway.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
June 2. Secy., C. H. McLeod, Montreal, P. Q.

ENGINEERS' CLUB OF MINNEAPOLIS.
June 2. Public Library Bldg. Secy., F. W. Cappelen.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
June 3. Secy., E. K. Smoot, 903 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
June 3. Secy., O. von Geldern, 819 Market St., San Francisco.

SWEDISH ENGINEERS' CLUB.
June 4. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
June 4. Union Station, St. Paul.

ENGINEERS' CLUB OF PHILADELPHIA.
June 4. 1122 Girard St. Secy., J. C. Trautwine.

WISCONSIN POLYTECHNIC SOCIETY.
June 6. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
June 6. Secy., C. L. Annan.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 6, 7. Grand Pacific Hotel, Chicago. Secy., E. W. Pope New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 8. Annual Convention, Old Point Comfort, Va. Secy., F. Collingwood, 127 East 23d St., New York.

NEW ENGLAND WATER-WORKS ASSOCIATION.
June 8, 9, 10. Holyoke, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
June 9. Secy., Edward Mead, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTHWEST.
June 9. Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
June 10. Union Station, St. Paul.

TECHNICAL SOCIETY OF NEW YORK.
June 11. 194 Third Ave. Secy., H. Schreiter.

ENGINEERS' CLUB OF KANSAS CITY.
June 13. Baird Building. Secy., Waterman Stone.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
June 14. Secy., Parker N. Hisch, Capitol Block.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
June 14. Secy., C. S. Howe, Case Library Building.

NORTHWESTERN SOCIETY OF ENGINEERS.
June 14. Occidental Block, Seattle. Secy., E. H. Warner.

DENVER SOCIETY OF CIVIL ENGINEERS.
June 14. Secy., Geo. H. Angell, Jacobson Block.

BOSTON SOCIETY OF CIVIL ENGINEERS.
June 15. Secy., S. E. Tinkham, City Hall.

MASTER CAR BUILDERS' ASSOCIATION.
June 15. Saratoga, N. Y. Secy., J. W. Cloud, Chicago, Ill.

ENGINEERS' CLUB OF ST. LOUIS.
June 15. Secy., Arthur Thacher, Odd Fellows' Building.

ENGINEERS' CLUB OF CINCINNATI.
June 16. Secy., J. P. Wilson.

MONTANA SOCIETY OF CIVIL ENGINEERS.
June 18. Secy., F. D. Jones, Helena.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 20. Saratoga, N. Y. Secy., A. Sinclair, New York.

WESTERN RAILWAY CLUB.
June 21. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
June 21. Secy., E. N. Clark, Pittsburg, Pa.

CENTRAL RAILWAY CLUB OF BUFFALO.
June 22. Secy., Jas. Macbeth.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 28. Bluff Point, N. Y. Secy., R. W. Raymond, New York.

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Englishmen who come to Chicago next year are being properly forewarned of the dangers which lie in wait for them. Commenting on the recent disaster on the Atchison, Topeka & Santa Fe due to the washout of a trestle, "The Engineer" says:

This will serve to remind the people who may have some thoughts of visiting the United States next year that these trestle bridge failures are much too common to make American traveling pleasant. It is high time that on lines leading to Chicago and elsewhere, carrying heavy trains, these bridges were properly inspected, and an impartial report as to their condition not only made but acted upon. It would be well if the absolute impartiality of the report and perfect freedom of criticism were secured by appointing, jointly by all the railways concerned, one or more English or continental engineers to act with the American engineers in the matter.

The comprehensive knowledge of American railroading, revealed in the above, is decidedly amusing. "Lines leading to Chicago and elsewhere carrying heavy trains" are evidently not extensive in the writer's estimation, as he thinks that one or two foreign engineers could attend to the inspection of the trestles on all of them during the next few months and render a report as to their condition, presumably in time to have them all rebuilt in accordance with English ideas before the opening of the Columbian Exposition. The implication that "absolute impartiality and perfect freedom of criticism" are not to be expected from American engineers was to be expected. For "The Engineer" knows well enough, but rarely admits, that American engineers know how to build structures as well and as safely as their cousins across the water; but as Portia said: "If to do were as easy as to know what 'twere good to do, chapels had been churches and poor men's cottages princes' palaces," and trestles had been solid fills or viaducts of masonry or steel.

For the benefit of the timid European, however, we may say that trestle failures on American railways are by no means common. In fact, a good wooden trestle, with proper guard rails and floor, is a tolerably safe structure, considerably safer, there is good reason to believe, than many cast iron girder bridges on British railways. The probabilities are that several foreign visitors to the Columbian Exposition will meet death through their own carelessness in getting on and off trains, but that not one will be killed or injured by the failure of a railway trestle.

The sands upon a sea beach are, from one point of view, almost a symbol of instability. The individual particle is never many minutes in the same place, if near the surface; never many days in the same place if a foot or more below the surface, and never many years in the same place even if many feet below the surface. Moreover, the swash of every wave throws millions of these particles against each other, affording many times the apparent opportunity for abrasion which occurs in rocky and pebbly beaches, where it often takes a pretty heavy wave to move the stones at all. How does it happen, then, that a sandy coast, taken as a whole, is so permanent; what is taken from one point being, as a rule, added at some other point near by? When one stops to think of it, it is remarkable that the steady lashing of the waves does not grind up the sand and carry it off to sea with greater rapidity. We must confess to having never stopped to think of it until we read the following suggestive passage from Prof. N. S. Shaler's article on "Sea-Beaches" in the current "Scribner's." We fancy that the same will be true of the majority of our readers, and if so the fact well illustrates how we may be blind to the meaning of the most simple and obvious natural functions going on all around us, until some one else notes and explains it. By equally simple reasoning from equally obvious natural phenomena many important discoveries have been made in the past, and perhaps are yet to be made in the future, as, for instance, the conversion of the heat of combustion into working energy direct, which nature seems to do easily enough without discoverable machinery in every living organism. Prof. Shaler says as to sea-beaches:

The sand, of which the bulk of the masses of sea beaches is composed, is vastly more durable than the seemingly more resisting pebbles. Pebbles wear out rapidly. Scarcely any, even the hardest, can stand a year of steady thrashing on the shore, but these sands endure for ages. The reasons for this are simple. In the first place, each grain of sand is an admirable illustration of the principle of the survival of the fittest. If it be not perfectly coherent and very hard, it will not be carried far before its weakness is found out and it is broken into mud on the pebble beaches, where it is generally made and borne away by the sea to the deeper water. Then, because of their smallness, the grains lie with so little interspaces between them that they hold the water next their faces by capillary attraction. When a wave strikes the shore the grains of sand are pounded together, but they do not touch each other. If we press on the wet sand with the foot we see that the mass whitens as the pressure is applied, and a part of the interstitial water is poured out; take the foot away and the water returns to the crevices between the grains. Only dry sand will rub grain against grain and give the audible sound which, when it is sharp and clear, is called singing. No beach will thus creak or sing beneath the foot when it is wet.

This curious endurance of rocky matter, in its comminuted form, of the erosive force of the sea makes the sand the natural protector of the land against the fierce assaults of the sea. If sand were easily pulverized, if it were readily floated away, if it had, indeed, any other than its actual assemblage of properties, it is doubtful if the lands could have made good their place in the contest with the ocean. These doughty little champions have certainly kept for our use empires, which, but for their good work, would long ago have vanished beneath the waves.

In this month's "Forum" Prof. Henry C. Adams, the Interstate Commerce Commission's statistician, writes on "The Slaughter of Railway Employees," and quotes from the statistics of the use of automatic brakes and couplers collected by his staff. As we have shown in these columns, these statistics are practically valueless; first, because they are about two years old before they are published, and, secondly, because they are collected with no knowledge of the different classes of automatic couplers and brakes, and hence show a great apparent diversity in the automatic couplers in use, whereas the fact is that the number of automatic couplers now in use aside from the M. C. B. type is too insignificant for notice. A better illustration of the way in which statistics can be made to prove what is not true can hardly be given. Prof. Adams says his statistics show an equipment of but 31,890 cars with automatic couplers in the year ending June 30, 1890, and that there are 44 different kinds of couplers and nine kinds of train brakes in use; this proves, he thinks, that the railways are not only proceeding with the brake and coupler reforms very slowly, but are working at cross purposes and adopting all sorts of devices. As a matter of fact, the annual rate of progress in equipment with automatic couplers is now not 30,000, but over 100,000; and as far as the requirements of interchangeability are concerned, there is practically but one form of automatic brake and one form of coupler in use. Prof. Adams' error as to the facts leads him into a still more serious error as to the action advisable. "It is practically impossible," says he, "for the railways, unaided by law, to secure the universal use of couplers and brakes of a uniform type. The aid of Government is required, not so much to coerce reluctant companies as to arbitrate between the advocates of various patents." He concludes, therefore, that while "it is a very delicate matter for the Government to say which of the many styles of couplers now in use shall be adopted to the exclusion of all others," yet the necessity is imperative, and if necessary the Government should purchase the patents of the approved type of coupler or brake and grant their use free of royalty to the railways.

It is much to be regretted that Prof. Adams, whose honesty of purpose no one will question, and whose position gives anything written by him a great deal of influence, should fall into such errors with regard to a matter on which it is his duty to inform himself. We have never seen any evidence in the articles from his pen that he has ever heard that concerted action has been taken by the railways of the country upon these questions, and that about one-fifth of the cars in the country are now equipped with automatic couplers of the M. C. B. type as a result.

The effect of Prof. Adams' mistake is the more serious because that intelligent portion of the public which has interested itself in the automatic coupler reform is sadly in the dark as to what has been and is being done. So intelligent a writer as Appleton Morgan in this month's "Popular Science Monthly" objects to President Harrison's recommendation to Congress to make compulsory the equipment of freight cars with automatic couplers on the ground that it would throw thousands of the employees out of work. This is his remedy for the situation:

If instead of so sweeping a law as the President suggests, a statute might be provided requiring the drawheads of all freight cars manufactured or admitted in the United States to be of a uniform height and to be within projecting frame corners (sic) from the rail surface, everybody can see that not only humanity, but perfect justice, both to the railway company and to the employee would be subserved.

We hope Mr. Morgan is quite clear as to what he means by "within projecting frame corners from the rail surface," for we are quite sure no one else will know. As for his law prescribing a uniform height of drawhead as a panacea, where will be his uniformity when a heavily loaded car with a drooped end comes against an empty car which has not seen much service? Truly, it is not entirely an evil that Congress is so busy manufacturing political capital that it has no time to listen to friends of humanity like Mr. Morgan.

Not very long ago the British Board of Trade issued an order that the commercial unit for the sale of electricity should be the kilowatt-hour, all of which was a very proper, though perhaps, not wholly necessary, proceeding. Immediately thereafter the English technical papers began to use the term, "Board of Trade units," and even in a report of a duty test of an electrical plant by a prominent professor in an English engineering school, we found the electrical energy generated given in "Board of Trade units." The reason for this misuse of words we have not yet been able to understand. The electric current is a permanent factor in civilization, and the sooner the general public is educated concerning it the better. All who are concerned will eventually come to understand the value of a kilowatt, just as they understand nowadays the terms horse power, or fluid pressure expressed in pounds per square inch, or degree of temperature. A kilowatt-hour is an amount of electric energy which, used in a motor, will give a little over a horse power for an hour. The term kilowatt, moreover, expresses its value in itself. It means something. The term "Board of Trade unit" may mean anything. The one is scientific and world-wide in its scope. The other is arbitrary, and means nothing outside of Great Britain.

It must also be admitted that "Board of Trade unit" is decidedly clumsy as compared with "kilowatt-hour." This fact attracted the attention of the Board of Trade, and after mature consideration they recently announced that the "Board of Trade unit" would in future be known as the "kelvin," in honor of Lord Kelvin. It is a safe prediction that not

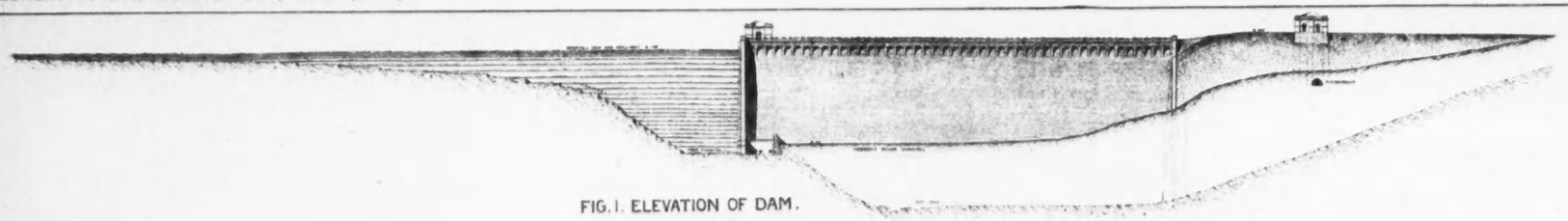


FIG. 1. ELEVATION OF DAM.

PLAN OF GATE HOUSE.

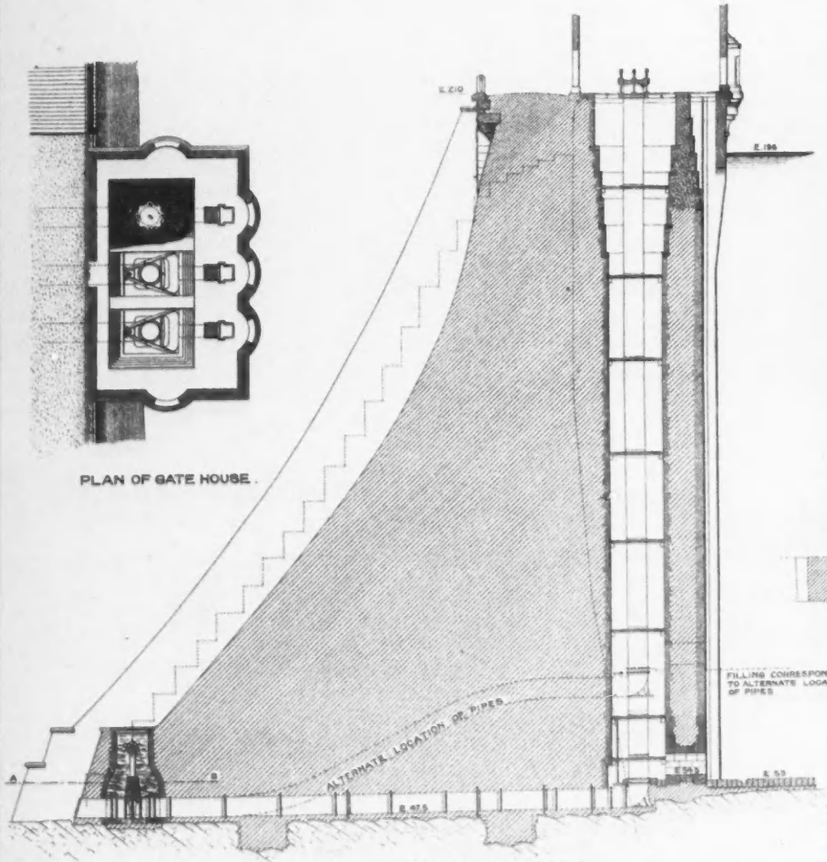
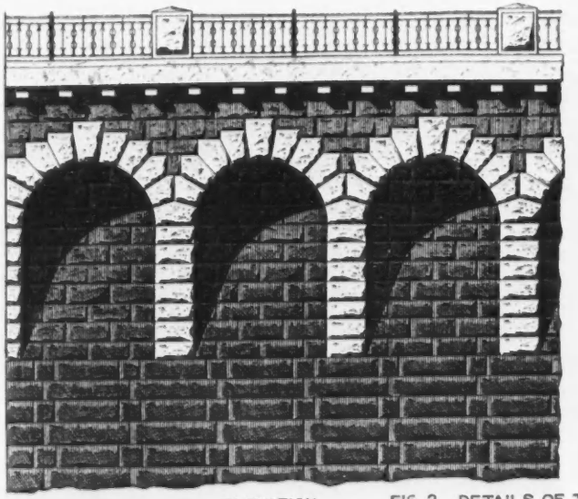


FIG. 3. DAM AND GATE CHAMBER.



ELEVATION

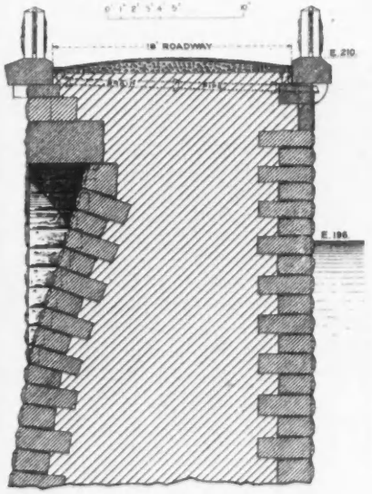
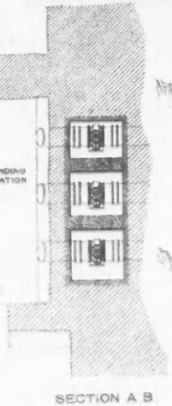


FIG. 2. DETAILS OF TOP OF DAM. SECTION



SECTION A B

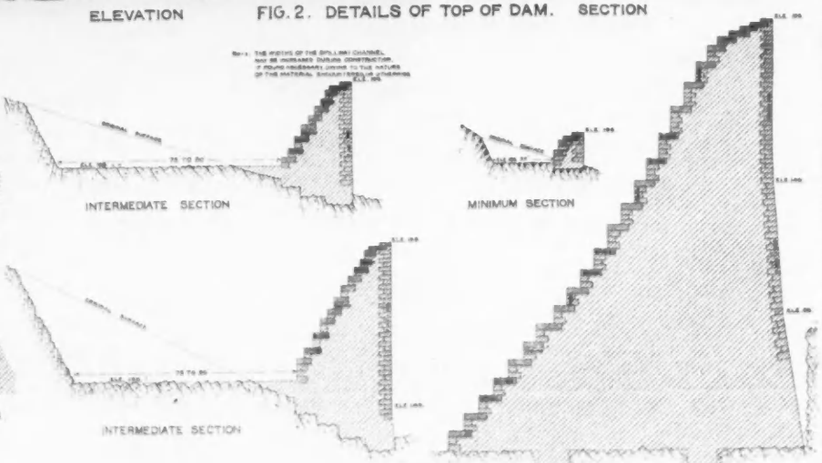
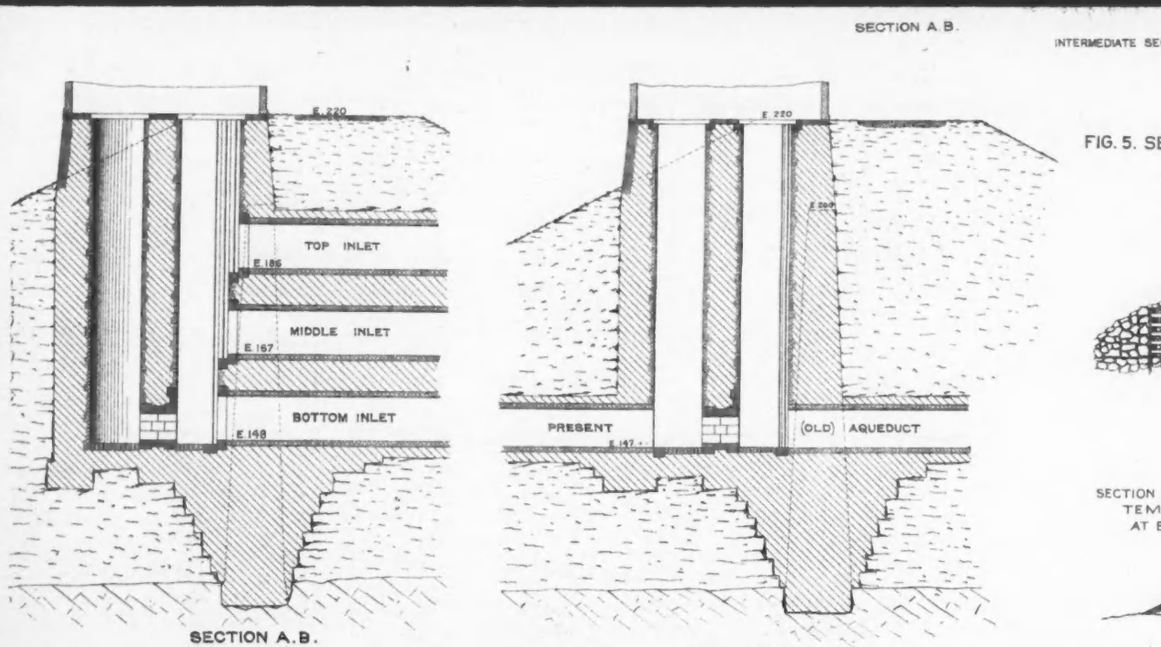


FIG. 5. SECTIONS THROUGH OVERFALL.



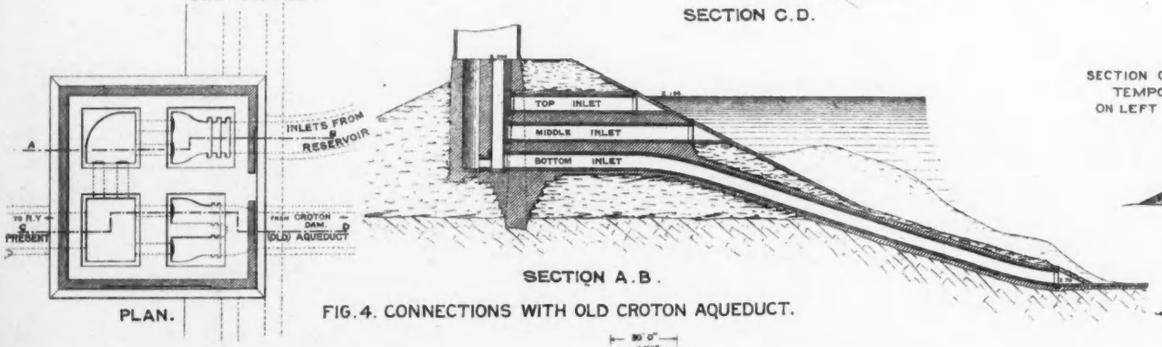


FIG. 4. CONNECTIONS WITH OLD CROTON AQUEDUCT.

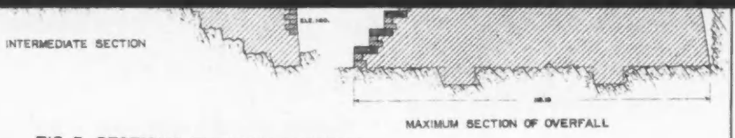
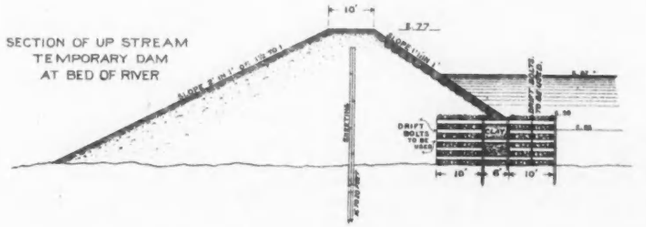
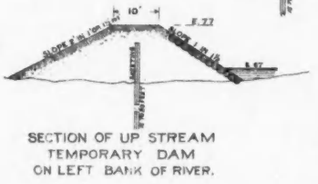


FIG. 5. SECTIONS THROUGH OVERFALL.





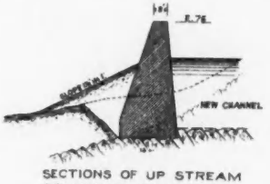
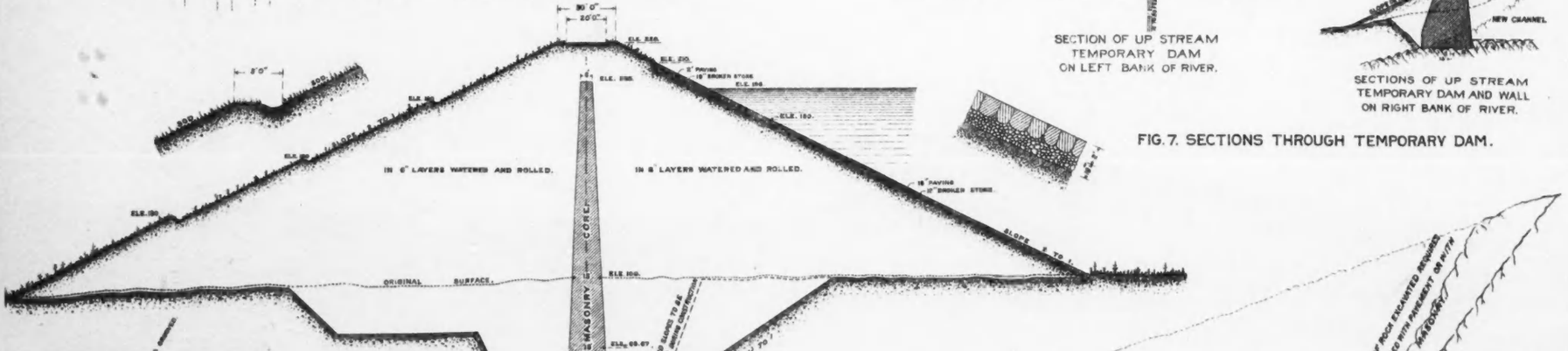


FIG. 7. SECTIONS THROUGH TEMPORARY DAM.



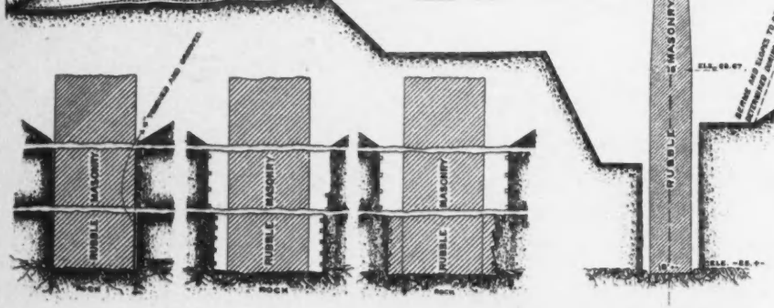


FIG. 6. SECTION AND DETAILS OF EARTH DAM.

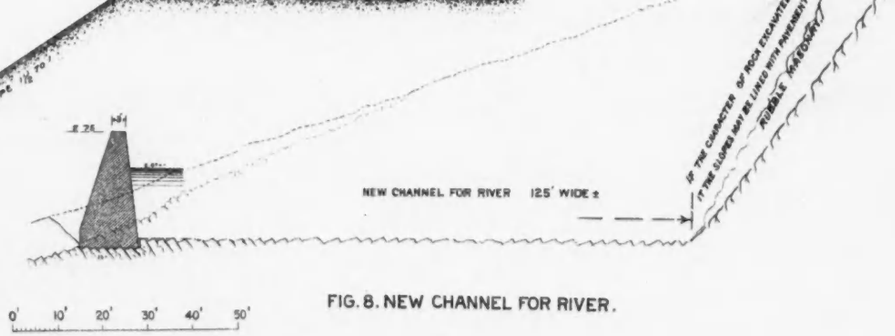


FIG. 8. NEW CHANNEL FOR RIVER.

0' 10' 20' 30' 40' 50'

THE NEW CROTON DAM FOR THE NEW YORK WATER-WORKS. A. Fteley, Chief Engineer.

LMAS HART & SONS, LITH., 34 VESEY ST., N. Y.

one in a hundred of our readers but will wonder who Lord Kelvin is, not knowing that Sir William Thomson has recently surrendered the name which he has made illustrious for that barren distinction. But apart from the brand-newness of this title, which the scientific world knows nothing of, and has no reason to hold in honor, this action of the Board of Trade seems open to criticism from every point of view. In the first place, it was no more necessary to coin a new word in place of "kilowatt hour" than to coin one in place of "horse power hour." A word which expresses its meaning by its etymology is, in this case at least, preferable to one which expresses no meaning whatever. In the second place, it is certainly in questionable taste to adopt for the name of a new unit the name of a living electrician, who is still engaged in practice, even admitting his eminence as a scientist and inventor; and in the worst possible taste to seek to pay him a compliment as a scientist by choosing that one of his names which, if it honored him at all, honored him by lifting him out of the vulgar crowd who have achieved greatness into that which is supposed to have been born great.

We notice with satisfaction that the British technical journals have been quick to see the absurdity of coining a new unit for which no need existed, and several of them speak their minds freely. "The Engineer" says, sarcastically:

> It has been found that suppliers and consumers do not understand what is meant when speaking of lighting gas per 1,000 cu. ft., or per 1,000, so in future it is proposed to speak and write per Murdoch instead. Water supplied by meter is for similar reasons to be sold at so much per Myddelton. Milk per quart is to be sold under the old name.

It is reported in our latest exchanges that Lord Kelvin has shown his good sense by requesting the Board of Trade to rescind its action, objecting to the honor thus thrust upon him. Perhaps the incident will serve to put a restraint on those who are eager to coin new words and name new units in electrical work.

WHAT'S IN A NAME?

We have received from a valued correspondent and contributor a proposed "new definition" of the terms "stress" and "strain," the nature of and reasons for which he expounds in the letter below given. As we do not wish to discourage him from continuing his much appreciated contributions to this journal, and yet feel bound to "pitch into" the position which he takes in this particular case, we do not give his name; but the letter in which he makes his suggestions reads as follows:

Sir. I wish to submit a new definition of "Stress" for the thoughtful consideration of engineers, and especially of the professors in our numerous engineering schools, concerning which you are now giving us such valuable information in your columns. I understand the facts to be these: An external force applied to a solid body "strains" or distorts it, which distortion develops a corresponding resistance to this molecular derangement, which resistance is called "stress." In other words:

"Strain" is the distortion of a body by an external force, while "stress" is the internal resistance to such distortion.

In accordance with these definitions we would say that the modulus of elasticity is the ratio of the stress in pounds per square inch to the proportionate distortion which produces it; that is to say, the external force is the primary cause; the strain, or distortion, is the immediate effect, which effect is always accompanied (in solid bodies) by a resistance which we call stress. The strain thus becomes the proximate cause of the stress, and not the stress the cause of the strain, as usually stated. For a resistance cannot be the cause of the thing resisted. The external force and the internal stress are related to each other as action and reaction, and must always be in static equilibrium in bodies at rest. This equilibrium always is accompanied by a proportionate distortion of the body, which stands as an effect of the active external force, and as a cause of the passive internal resistance.

Is it not highly probable that a confusion of ideas, names and logical relationship here is the primary cause of so much confusion and misconception, which surrounds all the ordinary problems in stress, strength, flexure, elastic limit, elastic and ultimate strength of beams, etc.? It needs hardly be said that for all scientific purposes the definition of strain here given has now become fixed, and should be universally adopted. There are a few American authors still using "strain" where "stress" is meant, and so far as I am aware, all writers speak of the distortion or strain as an effect of the stress in the body when it is really the cause. For young minds nothing is more important than logical definition, and logical use of words to prevent a confusion of ideas. As teachers and writers, therefore, ought we not to adopt the use of these words as here given?

On referring to the Century Dictionary we find the two words defined (so far as relates to their scientific use) as follows:

STRAIN.—4. In mechanics, a definite change in the shape or size of a solid body setting up an elastic resistance, or stress, or exceeding the limit of elasticity. The deformation of a fluid is not commonly called a strain. The word, which had previously been ill-defined, was made a scientific and precise term in this sense by Rankine in 1850. Thomson and Tait, in their "Treatise on Natural Philosophy," extend the term to deformation of liquid masses, and even of groups of points; and Tait subsequently extends it to any geometrical figure, so that it becomes a synonym of deformation.

> "Fresnel made the very striking discovery that glass and other simply refracting bodies are rendered doubly refracting when in a state of strain. To this Brewster added the observation that the requisite strain might be produced by unequal heating instead of by mechanical stress." Tait, Light, p. 292.
>
> "In this paper the word strain will be used to denote the change of volume and figure constituting the deviation of a molecule of a solid from that condition which it preserves when free from the action of external forces." Rankine, Axes of Elasticity, (1855).
>
> "A strain is any definite alteration of form or dimensions experienced by a solid. . . . If a stone, a beam, or a mass of metal in a building, or in a piece of framework, becomes condensed or dilated in any direction, or bent, or twisted, or distorted in any way, it is said to experience a strain." W. Thomson, Mathematical Theory of Elasticity, (1856).

STRESS.—2. In mechanics, an elastic force, whether in equilibrium with an external force or not, the force called into play by a strain. This word was introduced into mechanics by Rankine in 1855. In the following year Sir William Thomson used the word as synonymous with pressure, or an external force balanced by elastic forces. The terminology has been further confused by the use of Rankine's word strain, by Thomson and others, as a synonym for deformation. The words stress and strain are needed in the senses originally given to them by Rankine; while they both have familiar equivalents to which they have been wrested. At present, some of the writers use them in one way and some in the other.

> "In this paper the word strain will be used to denote the change of volume and figure constituting the deviation of a molecule of a solid from that condition which it preserves when free from the action of external forces; and the word stress will be used to denote the force, or combination of forces, which such a molecule exerts in tending to recover its free condition, and which, for a state of equilibrium, is equal to the combination of external forces applied to it." Rankine, Axes of Elasticity, 2.
>
> "A stress is an equilibrating application of force to a body. . . . It will be seen that I have deviated slightly from Mr. Rankine's definition of the word stress, as I have applied it to the direct action experienced by a body from the matter around it, and not, as proposed by him, to the elastic reaction of the body equal and opposite to that action." Thomson, Phil. Trans., CLXVI., 487.

It will be seen that these definitions are somewhat in conflict with each other. "Strain" is defined as "a definite change in shape of a solid body," i. e., as a distortion, and not at all as a force producing a distortion; while under "stress" we are told that it is "the force called into play by a strain," which can only mean (if the sentence was written carefully) that a strain is a force and not a distortion produced by force. Moreover, the use of "Rankine's word strain" (when and how did he acquire title to it?) as a "synonym for deformation" is objected to in the very same sentence, though Rankine's own words, as quoted in the following sentence, distinctly declare that strain means a deformation and nothing less. The subject was evidently not clear in the mind of the writer of the definition, whoever he was, as is very natural for reasons which we shall shortly see.

Nevertheless, the attentive reader of these definitions can hardly fail to see that, although the writer of them was somewhat mixed in his own mind, the definitions quoted from Rankine (to which he evidently intended to conform) are practically identical with those proposed as "new" by our correspondent, and, therefore, there appears to be small grounds for bringing forward as a newer gospel the definitions which our correspondent wishes to see established.

Does it not tend to make confusion worse confounded to thus make up and proffer for acceptance new definitions, without first taking the trouble to see and state to what extent they are really new? It seems to us that it is not young minds only which are in danger of having their ideas confused by such independent juggling with words.

For having first admitted and shown that these proposed "new" definitions are already established, so far as recognized recent authorities can establish them, we desire to go further, and say that no "young" mind which has had the misfortune to be trained from his youth up in the English tongue can ever get a clear conception of the relations of "stress" and "strain" as thus defined, for the reason that one of the definitions at least (if not both) is not English, i. e., is not a permissible sense to give to the English word, but is mere scientific jargon, as arbitrary and as unwarranted by any analogy with the recognized meaning of the word as if scientists were to conclude that the verb "pull" had better mean to strike a hammer blow, and the verb "push" had better mean to place in tension.

Any "young mind" would necessarily stagger under such a load as this, and it must ever continue to stagger under such a preposterous distortion of the true meaning of a word as to say that "strain" means distortion in any sense, or ever did or can mean it as an English or Aryan word. For language is a subtle thing. It is almost like a living organism in its resistance to outside interference with its normal mode of growth. The roots of many simple words expressing elementary ideas, like stress and strain, have acquired a fixity of meaning which it is impossible to eliminate from the inner consciousness of those who first learned their meaning at their mother's knee. We may impress upon the consciousness of a Chinaman (perhaps, unless Chinese has the same root) that "strain" means a pig-sty, if we like, but we can make no one whose native tongue is English, or French, or German, or Latin, or Greek, or Persian, "sense" such a definition, or any other that does like violence to his acquired sense of the meaning of words. For as it happens the roots "st" and "str" are among the most prolific and determinate of all the ancient roots of the Aryan tongue. The root "st" has always, in all the European languages, the sense of stability or rest or inertness which is expressed five times over in the sentence "He stupidly stopped and stood stock still." With very little effort a series of a dozen or two different words of this kind in a sentence of about as many words may be framed in a dozen different languages. Similarly the root "str" has in every ancient and modern Aryan tongue dozens, if not hundreds of words like stress, strain, struggle, stretch, strive, strip, strike, strong, destroy, in which a more or less strenuous exertion of energy is implied. This meaning has been bred in the bone of the European races for thousands of years. We "strip" a man and leave him naked, but does "stripping" therefore mean "nakedness," or has any scientist the right or power to make us say it does? Just so much or so little right he has to tell us that because, when we "strain" a piece of iron we (more or less) "distort" it, therefore to "strain" means to "distort." The man who invented that definition may have been profoundly versed in mathematics, but he cannot have had a very profound respect for his native tongue. Scientists may struggle to all eternity to establish it in the consciousness of students, but they will never do so.

This is especially so because the definitions proposed by our correspondent as new, and also given in the Century Dictionary, are not only linguistically but scientifically bad and weak in this, that they seek to use only two names for three things. It is one of the axioms of engineering that when we are considering the application of force to a body there are three things to be considered, (1) the (magnitude of the) "strain" by which the body is affected; (2) the "distortion" or change of form produced in that body; (3) the (internal or molecular) "stress" (or "strain," if one likes) by which the distorting effect of the "strain" is resisted. But if, according to our correspondent, "strain is the distortion of a body by an external force," what are we to call that effect of an external force upon the body which causes distortion? No wonder the young mind is confused when it grapples with this conundrum!

As for the distinction between "stress" and "strain," it is in one sense a distinction without a difference, for both are from a late form of the same root, the Latin "stringere," and both have the same

elemental English signification of a stretching or deforming force or pressure. This definition is given for "strain" in the Century Dictionary with the added remark: "(This use of the word, while permissible in literature, is incorrect in mechanics. The strain is not the force, but the deformation produced by the force)." We repeat that this is not true as respects the instinctive use of words by the most learned man, and so long as professors try to make "young minds" believe it is true, so long they will produce confusion which mere added words will not straighten out.

To test the soundness of these opinions, let the reader read over again the middle third of our correspondent's letter as first quoted above, and see if it appears to his unaided intelligence much clearer than mud. Let him then rewrite it, using the word "strain" to signify the applied force, "stress" the internal resistance to that force, and "distortion" to signify the deforming effect of the equal and opposite "stress" and "strain," and see if all need for straining the attention to follow the meaning is not gone.

If our scientific men who are so over-ready to coin new words and meanings of words now-a-days would first make sure that they understand and have exhausted the resources of the living tongue, they would coin fewer words, and yet greatly add to the clearness of their writings or teaching. It is hard enough for the human mind to grasp new thoughts. Do not make it harder by needlessly demanding that new words shall be learned to express those thoughts, especially when those words do violence to the very genius of the language, and of all languages.

LETTERS TO THE EDITOR.

SWITCHBACK RAILWAYS.

Sir: In your issue of May 12 appears a communication from J. M. O., asking for information about "Switchback Railways." If your correspondent refers merely to the so-called "switchbacks" for pleasure railways he can obtain particulars by addressing Wilbur Bros., 2010 W. Third St., Sioux City, Ia., and inquiring as to Thompson's pleasure railways. Yours truly,

Waterman Stone.

Kansas City, Kan., May 19, 1892.

ALUMINUM FOR ENGINEERING FIELD EQUIPMENTS.

Sir: Referring to an item in Engineering News of May 12 concerning the use of aluminum for military equipments, there are many articles required for engineering parties—particularly canteens—which could be made of aluminum with great advantage, and I have made several unsuccessful attempts to obtain the address of some party in America who is prepared to supply such articles in this metal. I shall be grateful if you can supply this information. Respectfully,

Banning, Cal., May 25, 1892. E. M. B.

(We cannot.—Ed.)

A LONG CABLEWAY IN AN EARTHQUAKE.

Sir: It may be of interest to readers of Engineering News to learn of what is probably the longest single span cableway in the world; and also of the remarkable accident that recently befell it. The cable is situated at the Deer Park group of mines, near Descanso, Cal., and is used for conveying ore from the mines high up a mountain side to the mills below. It has a single span of 4,450 ft., and has a tension of about 20 tons. The loads were 120-lb. sacks of ore. It was a working success for two days. It parted just after an extra hard "shake" in the series of earthquakes to which that part of California has been subjected. It is supposed that the vibrations coming from each end of the line and meeting in the middle, were the cause of the break. The cable is to be replaced at once by a heavier one. Yours truly, L. M. Hallam.

Amarillo, Tex., May 22, 1892.

LIMITS OF VARIOUS GRADES OF STEEL.

Sir: In your edition of May 19 you have an inquiry from a subscriber as to the defining lines between soft, medium and high steel for structural work. Being in a position where this question has been repeatedly asked by structural men, I have drawn up specifications for structural steel, giving the three grades, soft, medium and high, and the defining lines are given as per extract from the specifications below. Perhaps this may be of some service to Mr. Benj. F. La Rue, of Jackson, Mich., who made the inquiry.

Yours very truly,

Millard Hunsiker,

Engineer of Tests for Carnegie, Phipps & Co.

Pittsburg, Pa., May 23, 1892.

Grade of Steel.—Steel shall be of three grades: soft, medium, high.

Soft Steel.—Specimens from finished material for test, cut to size specified above, shall have an ultimate strength of from 54,000 to 62,000 lbs. per sq. in.; elastic limit one-half the ultimate strength; minimum elongation of 26% in 8 ins.; minimum reduction of area at fracture 50%. This grade of steel to bend cold 180° flat on itself, without sign of fracture on the outside of the bent portion.

Medium Steel.—Specimens from finished material for test, cut to size specified above, shall have an ultimate strength of 60,000 to 68,000 lbs. per sq. in.; elastic limit one-half the ultimate strength; minimum elongation 20% in 8 ins.; minimum reduction of area at fracture, 40%. This grade of steel to bend cold 180° to a diameter equal to the thickness of the piece tested, without crack or flaw on the outside of the bent portion.

High Steel.—Specimens from finished material for test, cut to size specified above, shall have an ultimate strength of 66,000 to 74,000 lbs per sq. in.; elastic limit one-half the ultimate strength; minimum elongation, 18% in 8 ins.; mimimum reduction of area at fracture, 35%. This grade of steel to bend cold 180°, to a diameter equal to three times the thickness of the test piece, without crack or flaw on the outside of the bent portion.

Sir: In answer to your editorial remarks to your correspondent, in your issue of May 19, as to the defining lines between soft and medium steel and medium and hard steel, I have to agree with your general statement that there are no closely drawn conventional lines defining these classes of steel, but I would state that the terms as referring to structural steel are within narrower lines than those which you mention in your editorial.

The usual requirements of bridge specifications for structural steel allow a limit of 8,000 or at most 10,000 lbs. per sq. in. The soft steels have had increased range within the last two years, by the introduction of very soft basic steel, which, being low in phosphorus, as well as in carbon, has decreased the tensile strength of the product considerably. The best of soft basic open-hearth steel often runs as low as 48,000 lbs. tensile strength per sq. in.; so that in my experience with specifications the term "soft steel" refers to steel from 48,000 to 62,000 lbs. tensile strength per sq. in.; the average soft steel being from 52,000 to 60,000 lbs. per sq. in.

The medium steel has a range of from 56,000 lbs. to 68,000 lbs. tensile strength per sq. in.; the average being from 58,000 to 66,000 lbs. tensile strength per sq. in.

The term "hard steel," used for structural purposes, refers to steel of from 66,000 to 78,000 lbs. tensile strength per sq. in.; the highest specifications of late having been for 70,000 to 78,000 lbs. tensile strength per sq. in.; the average hard steel being a metal of from 66,000 to 74,000 lbs. tensile strength per sq. in.

The requirement is now becoming quite general (and it seems to me to be a fair one), to call for the minimum elastic limit to be one-half the ultimate strength.

The average ductility requirements with the steel referred to have been: for soft steel from 52,000 to 60,000 lbs. tensile strength per sq. in., an elongation in 8 ins. of 26%; minimum reduction of area, 50%; character of fracture, silky.

With the average medium steel, 23% elongation in 8 ins.; 45% reduction of area; character of fracture, silky.

For the hard steel, an elongation of 18% in 8 ins.; reduction of area of 35%.

The only chemical requirement in the general specifications of to-day is that phosphorus shall be below 0.08%.

I agree with you as to the disadvantage of using these terms except as designating steel whose specification has been more definitely outlined in other articles. I do not agree with you, however, in the further statement that the exact meaning of the term can be as well expressed "in the exact limits of carbon;" due to the fact that the amount of phosphorus and manganese has much to do with the character of the steel for structural purposes, as well as the carbon. To-day, a steel of, say 0.15% carbon, may have a tensile strength varying from 50,000 lbs. per sq. in. up to 70,000 lbs. per sq. in., according as the steel is made, by the basic open-hearth process on the one hand, and has an amount of phosphorus below 0.01%, or by the acid Bessemer process on the other, with a maximum phosphorus of 0.08% and manganese of over ½%.

The data given above are from my own experience with many specifications for structural material within the last two years, and I may add also are confirmed by the leading manufacturers of structural material in the country. Carnegie's excellent new handbook contains a specification for structural steel (given above), which is within the limits specified in this letter.

Very respectfully,

Alfred E. Hunt.

Pittsburg, May 24, 1892.

(Our statement that specifications for steel should designate just what grade of metal is wanted, "giving the exact limits of tensile strength (or carbon if desired)," should not be construed as an expression of opinion that the carbon limit is as good as the strength limit. We have often expressed our belief that chemical analysis alone is a most untrustworthy indication of quality. The question whether physical or chemical requirements should both be introduced in specifications has been thoroughly fought over, and we believe the best and usual practice today is to omit all requirements as to limits of carbon. Still there may be engineers who cling to the old way, and who would not consent to use steel without a carbon clause in the specifications. It was in recognition of their opinions and their right to act on them if they desired, that we inserted the parenthetical clause. Mr. Hunt gives so good a reason for the better practice of the present day that we trust any engineer who still calls for steel with not over such or such a per cent. of carbon will give it a careful consideration.—Ed.)

PRECISE LEVELS OF THE MISSISSIPPI RIVER COMMISSION.*

It is the custom of the Commission in the general survey of the river to run first precise levels, then triangulation, and lastly topography, the benchmarks of the levels serving as a basis for the subsequent surveys.

These benches are from two to three miles apart, and are mostly on the foundations of buildings, the piers of bridges, or natural ledges of rock; and are marked U. S. P. B. M. (United States Permanent Bench Mark). The exact point is the top of a small copper bolt, leaded into the rock. In case there are no buildings or natural ledges, the cooper bolt is leaded into a hole in the center of a slab of vitrified fire clay 18×18×5 ins., buried about 4 ft. in the ground, and accessible from the surface through a 4-in. pipe. Besides these, temporary or ordinary benches are taken at the end of a stretch, usually about 1,200 meters apart. They are merely points of reference from one day to another, but are made as permanent as possible. Usually they are points on large embedded boulders or on foundations of buildings, or on spikes in the roots of trees.

The instrument used is what is known as the Swiss or Kern level. It has three leveling screws, an auxiliary tangent screw under one wye, a striding level with a radius of curvature of 380 ft., and three cross hairs for reading the rods. The latter are graduated to centimeters, and are read by the estimation to millimeters and half millimeters. The rod is 3 ins. wide, 1 in. thick, and 3 m. (10 ft.) long, with a strip along the back to stiffen it. Two rods are employed with each instrument, according to the method described in Baker's "Leveling" as System II.

The usual party is as follows: One instrument man or observer, one recorder, two rodmen, and two umbrella men, one of whom under ordinary circumstances serves as axeman, and in case of thick underbrush or other like obstruction an additional axeman.

The length of sight varies from 40 to 125 m., the average being about 70 m. (230 ft.) except in extraordinary cases, as, for instance, a river crossing, where sights are 600 ft., or over, when a series of observations are taken.

The cost of these levels varies greatly with circumstances, and runs from $15 to $35 per mile. The average cost, however, is about $20 per mile. One reason why this is so high is that only 6 to 7 hours per day can be utilized on account of the tremulousness of the atmosphere in the middle of the day. From 5 to 8 or 9 a. m., and from 3 or 4 to 7 p. m. are the best hours of the day.

All stretches must have two lines run over them, and the results of these two compared. The limit of difference allowed is 3 mm. √dist. in kilos.=(0.012 ft. √dist. in miles).

The direct line between terminals is called the main line, and other lines, such as connections with bench marks, city datum, etc., are called the side line. In the work of 1891, between St. Paul and Savanna, a distance of 301 miles, there were 394 stretches in the main line and 300 in the side lines. Of these 694 stretches, 55 were run more than twice and 11 more than four times, on account of the results differing more than the allowed limit. The total length of the main line between St. Paul and Savanna is 486.00 kilos. The probable error of the difference in elevation is 13.7 mm., or 0.62 mm. × √dist. in kilos. (=0.0026 ft. √dist. in miles).

The rate of progress for a double party was about 2 miles per day. The longest run made by a single party in a day was about 3½ miles.

* A Paper by R. J. Dickinson, '93, Univer. Ill., in the "Technograph."

SOME OF THE CIRCUMSTANCES AFFECTING THE QUALITY OF A WATER SUPPLY. (a)

There are several sources of contamination to which water is subject on its way to the consumer. Ground waters dissolve mineral substances, rain water appropriates floating organic matter from the air, while surface water takes up a great variety of substance in its flow. Some of the foreign material which is appropriated in these different ways may be exceedingly deleterious, and a study of all the circumstances affecting the quality of water would be broad enough to compass the whole question of water supplies from the sanitary point of view. The present paper was therefore limited to a consideration of the subject from the natural history point of view, a tabulation of the microscopical life found in the Hemlock Lake water supply of the city of Rochester, N. Y., being given by way of illustration.

Hemlock Lake is 28 miles from Rochester, in a deep narrow valley with bold, steep shores, the hills to either side rising to several hundred feet above the lake. The drainage area is about 26,000 acres, with 18,000 to 19,000 in cultivation. The geological formation of the bluffs is the Marcellus Shale, into which the basin of the lake extends more than 70 ft.

A table is given in the paper embodying all the chemical analyses of this water which, so far as the writer knows, have thus far been made. This table shows that both albuminoid and free ammonia are quite low in this water, the largest quantities having been found by Professor A. R. Leeds in 1891, when 0.022 of albuminoid and 0.0015 parts per 100,000 of free ammonia were present. Nitrates were present in 1881, to the amount of 0.63 parts for 100,000. Chlorine showed a trace only in 1877, 0.194 parts in 100,000 in 1881, and 0.34 as a maximum in 1889. Total hardness was 5.48 parts in 1881, total solids 9.99, mineral matter 3.99 and organic and volatile matter 6.00 parts for 100,000.

All the chemical analyses were made previous to 1890, while the quantitative determinations of microscopical life were made mostly in 1891 and 1892. The chemical and microscopical analyses, while therefore, not comparable in point of time, may be still both taken as confirming the view that this water is nominally of high organic purity.

The amount of life in even very pure water is now known to be large, which may be easily predicated, when it is considered that the larger bodies of water are inevitably the final depository of the biological fauna of the entire tributary drainage area.

Plant forms have been identified in Hemlock Lake as follows: Chlorophyceae, 20; Cyanophyceae, 15; Desmidieae, 14, and Diatomaceae, 41; making a total of 90 plant forms. The maximum quantities of some of these minute plants per 100 cu. cm. are: Protococcus, 2,000; Anabaena, 20,000; Coelosphaerium, 34,000; Asterionella, 40,000; Cyclotella, 60,000; Fragillaria, 25,000; Stephanodiscus, 60,000. The total number of animal forms is given as 92, of which 3 are classified as Spongidae; 10 as Rhizopoda; 29 as Infusoria; 12 as Hydroida; 14 as Rotifera; 3 as Polyzoa; 21 as Entomostraca; 1 as Malacostraca; and 10 as Insect larvae. As to maximum qualities of animal forms observed, we find among Infusoria, Dinobryon 12,000; Glenodinium 25,000 and Vorticella, 9,600.

In regard to the several species of plants and animals tabulated it is stated that while the quantitative microscopical determinations have all been made recently, the qualitative have extended over several years, the earliest having been made as long ago as 1876. The tabulations represent in this particular the work of several observers, no person having yet seen every form tabulated. It is considered, however, that all the species included are present in this water, although a few of the rarer ones are still to be verified.

The quantitative examinations are hardly as complete as could be wished. It is only in the last three years that any method of enumeration at all has been available and lack of time for work of this character has thus far prevented such systematic study as would result in a complete enumeration. The quantitative results given are the maximums from the examinations thus far made, which as already stated are mostly included in the last 16 months. A number of forms as for instance volvox globator, which have been the cause of objectionable tastes and odors in former years, have not been since the quantitative examinations began.

A few interesting points have been worked out which have not been referred to by the writer in previous papers on this subject, as, for instance, it is found that Anabaena is present on the surface of the lake in what is known as the agglutinated form in the spring and summer and at the time entirely absent from the distribution mains in the city. In the winter it is found in nearly equally large quantity in the distribution system and absent from the surface of the lake. The mouth of the supply conduit at the lake is about 30 ft. below the low water level of the lake surface, whence it is concluded that while in winter this little plant takes to deep water, in warm weather, on the contrary, it prefers the light and warmth of the upper stratum. The observations thus far made show the quantity of this alga per unit of the value to be larger in summer than in winter. The amount recorded in the table, however, 20,000 per 100 cu. cm., is from the distribution system in winter and represents single filaments, each averaging about 0.0002 in. in diameter and from 0.02 to 0.1 ins. in length.

In regard to the seasonal distribution as indicated in the table this is stated to be somewhat provisional. During the years in which the writer has been interested in the minute life in potable water relatively more opportunity for study of the question has existed in the winter than during the balance of the year, a fact which may possibly account for the assignment of some of the species to that season as their period of greatest development. The recurrence of certain forms in quantity at about the same time from year to year has, however, been noted often enough to indicate what may be termed a fixed periodicity of some of the microscopical life. But this cannot be affirmed of all the species; some of them have appeared once only in a series of years. Of such volvox globator, which developed in large quantity in the fall of 1888, may be mentioned. Again other forms have been present from year to year in small quantity, but have developed in large quantity once during the period of observation. This is also especially pronounced in the case of the diatoms Cocconema and Encyonema which have been observed in small quantity in the spring and summer from year to year, but which developed in vast quantities in a few days in the spring of 1889.

The systematic studies of the water supplies of Massachusetts, which have been made by the State Board of Health of that state, have shown that a knowledge of the minute life in detail is absolutely indispensable for a proper understanding of the sanitary qualities of a water supply. The magnificent discussions of all phases of the question which the Massachusetts Board have published in the last few years demonstrate this proposition so thoroughly that it is unnecessary to offer any proof, other than that afforded by the Massachusetts work as published in the several reports. It may be taken as settled that a knowledge of the microscopical organisms will, in the future, occupy a very important place in a systematic study of the sanitary value of a public water supply. The circumstances affecting the quality are found to be of wide range and the tabulation of the minute life of the Rochester supply may be taken as showing one direction at any rate in which the matter must be probed, in order to arrive at full knowledge of the detail.

This proposition is considerably enforced, when we study certain water supplies where quantity of minute life is far in excess of anything ordinarily occurring in Hemlock Lake; and, as illustrative of a supply with what is apparently an abnormally large quantity of minute life constantly present, we may refer to the Ludlow reservoir at Springfield, Mass., where the following maximum quantities per 100 cu. cm. have been observed: Of the diatoms, Asterionella and Melosira, 405,600 in April, 1890; of the algae Coelasphaerium, 157,600 in August, 1889; Chlorococcus, 322,400 in October, 1889; of animal forms the infusorian Dinobryon showed 264,400 per 100 cu. cm. in February, 1890.

But even the large quantities of minute life found at Springfield are dwarfed into comparative insignificance by the results of a series of examinations of the water supply at Newport, R. I., as given by Dr. T. M. Drown in a recent report, from which it appears that on Aug. 31, 1891, there were present in Easton's pond, one of the sources of supply for Newport, the large number of grass-green algae (Chlorophyceae) of 677,750 per 100 cu. cm.; on Sept. 11, 1891, there were found 927,400; on Oct. 8, the number had fallen to 675,700, but subsequently again rose until the enormous maximum was attained on Jan. 18, 1892, of 1,428,600 per 100 cu. cm. Diatoms were present on the same date to the amount of 200,700 per 100 cu. cm., giving a total of diatoms and grass-green algae of 1,629,300.

As correlated to the quantity and quality of the microscopical life the question of the food supply of the animal forms may be briefly discussed.

In reference to the food supplies of the protozoa and classes immediately higher in the scale it may be said:

(1) That the chief food of fresh water sponge is largely the minute spores of algae, although the sponge as growing attached to a fixed place cannot be considered as having much power of selecting, and may therefore, at times, take into its organism animal food also. It apparently receives and digests anything which the flowing waters in which it is usually found may bring to it. The proof that algae may be considered the chief food is derived principally from the fact that the sponge apparently prefers localities where algae spores are more abundant than infusoria.

(2) Rhizopods, according to Prof. Leidy, chiefly devour desmids, diatoms and other minute algae; and many of the illustrations in his "Fresh Water Rhizopods of North America" show the little animals in the very act of ingesting the various forms of plants which they apparently prefer. The reoccurrence of examples of this character leads to the conclusion that the rhizopods, unlike the sponge, have some power of selection and are able to exercise a degree of preference. Some species of rhizopods feed on infusoria and rotifers as well as desmids, diatoms, zoospores, etc., and among such Actinophrys, Actinosphaerium and Acanthocystis may be mentioned as preferring a mixed diet.

(3) The infusoria probably take whatever comes in their way. The movement of the flagella and cilia of the different classes set the water in the vicinity of each individual in motion and everything within reach, and not of too large size, to enter the oral aperture is received, digested and the refuse excreated the same as with other animals. Some species prefer decaying animal matter (Paramecium, Coleps, Vorticella, etc.), and are usually found in vast quantity where such decay is taking place. Others (Trachelocerea, etc.,) are found among vegetable debris, filaments of decaying algae, etc. Algae spores are probably a large portion of the food of the infusoria the same as with the rhizopods.

(4). In the next higher class of animals, we find hydra which is essentially a carnivorous feeder, worms, entomostraca and other animals falling an easy prey whenever they venture within reach of the moving tentacles.

(5) Polyzoa feed mostly on desmids, etc., with decaying vegetable matter; they have a finger or tongue-like organ stretching over the mouth, which seems to enable them to exercise some selection of the food coming within reach. They have been seen to swallow rotifers and probably take more or less animal food.

(6) Rotifers are like infusoria, in that the rotating apparatus from which they derive their name, is in rapid motion when feeding and brings into the capacious mouth which characterizes most of the species, whatever happens to be in the vicinity, although some power of selection may be observed. Rotifer vulgaris, the type of all the rotifers, is usually found feeding on decaying algae, etc.

(7) The Entomostraca are largely carnivorous, a number of species preferring decaying animal matter.

The foregoing, while a very brief resume of this part of the subject, is sufficient to further indicate the considerable variety of circumstances which may materially affect the quality of a water supply, and still be entirely overlooked until microscope is brought into the investigation.

(a) Abstract of a paper by Mr. Geo. F. Rafter, C. E., read before the American Water-Works Association, May 18, 1892.

THE SANITARY DIVISION OF THE BOSTON STREET DEPARTMENT.

The sanitary division of the Boston Street Department, as described in the report of the department for 1891, removes offal, ashes and dirt, but leaves street cleaning to a separate department.

Fresh offal is carted to various yards, from which it is removed daily by farmers, who pay an aggregate of $30,000 per year for this matter. About 3 per cent. of all the offal collected is decayed. This is taken to the dump scow and towed out to sea. The amount of offal removed during the last ten years has increased from 28,385 loads (57 cu. ft. per load), or 1,617,945 cu. ft., to 46,742 loads, or 2,664,294 cu. ft., in 1891. This increase has been constant, except that 1883 was slightly below 1882.

The amount of ashes, house and store dirt collected and removed in 1882 was 159,197 loads, and in 1891, 313,464 loads, each load being equal to 43 cu. ft.; the respective totals in cu. ft. were 6,845,471 and 13,478,952. The yearly increase in this particular has also been continuous, except in one year. The offal, it will be seen, has increased about 65 per cent. and the ashes about 96 per cent. in volume in ten years.

The offal and such refuse as are now towed to sea are carried in the patent Barney dumping scows. These scows discharge their load in a compact mass, 6 ft. below sea level. The offal is thus saturated and sinks to the bottom instead of floating on the surface. The city owns one scow, paying a yearly royalty of $1,500 for it, and rents another for $5,475 per year.

To remedy the frequent and apparently well-grounded complaints as to offal which had been dumped at sea being washed back upon the beaches of adjoining towns, several dumping places, instead of but one, have been used, and the offal is now dumped so that the wind will carry it out to sea.

THE UTILIZATION OF THE POWER OF OCEAN WAVES.

At the recent meeting of the American Society of Mechanical Engineers at San Francisco, Mr. Albert W. Stahl, U. S. N., Asst. Naval Constructor, presented an exhaustive discussion of the subject above stated. The possibility of "harnessing the waves" has long been an attractive one to inventors, as the Patent Office records testify; but the subject has received little attention from engineers. We do not now recall any other paper of importance on the topic anywhere in technical literature.

Mr. Stahl's paper was really a fairly complete treatise on the subject of wave power and its utilization, being 56 pages in length. It opened with a discussion of the trochoidal theory of wave motion, which is the theory now generally accepted as a sufficiently close approximation to the actual motion of water waves. According to this theory each particle of water in a trochoidal wave moves in an elliptical orbit, whose major axis is horizontal, and the plane of which is vertical and perpendicular to the wave ridge or crest. The motion of the particle in the upper portion of its orbit is in the direction of advance or propagation of the wave; in the lower part of its orbit motion is in the opposite direction. The eccentricity of the ellipses depends on the ratio between the length of the wave and the depth of the water. When the depth is one-half the length of the wave or more the ellipses cannot practically be distinguished from circles.

From his discussion of the form and method of motion of the wave, the author is enabled to deduce the following formula for the total energy of an indefinite series of deep sea waves, expressed in horse power per foot of breadth.

$$\text{HP. per ft. breadth} = .0329\ H^2L\left(1 - 4.935\frac{H^2}{L^2}\right)$$

in which H and L = the height and length of the wave respectively, expressed in feet. The following table is computed by this formula:

Total Energy of Deep Sea Waves in Terms of Horse-Power per Foot of Breadth.

Ratio of length of waves to height of waves.	Length of Waves in Feet. 25	50	75	100	150	200	300	400
50	.04	.23	.64	1.31	3.62	7.43	20.46	42.01
45	.05	.29	.79	1.62	4.47	9.18	25.30	51.94
40	.06	.36	1.00	2.05	5.65	11.59	31.95	65.58
35	.08	.47	1.30	2.68	7.37	15.14	41.72	85.63
30	.12	.64	1.77	3.64	10.02	20.57	56.70	116.38
25	.16	.90	2.49	5.23	14.40	29.56	80.85	167.22
20	.25	1.44	3.96	8.13	21.79	45.98	126.70	260.08
15	.42	2.83	6.97	14.31	39.43	80.94	223.06	457.80
10	.98	5.53	15.24	31.29	86.22	177.00	487.75	1001.25
5	3.30	18.68	51.48	105.68	291.20	597.78	1647.31	3381.00

The above table gives the total energy, including both kinetic and potential, inherent in a regular series of waves. The figures are strictly correct for the trochoidal deep-sea wave with circular orbits only, though they give a close approximation for any nearly regular series of waves in deep water, and a fair approximation for waves in shallow water.

After concluding his discussion of the mathematical theory of wave motion, the author takes up the question of the practical utilization of wave energy, as follows:

Of the motions of the wave particles which may be utilized for power purposes we find the following:

1. Vertical rise and fall of particles at and near the surface.
2. Horizontal to-and-fro motion of particles at and near the surface.
3. Varying slope of surface of wave.
4. Impetus of waves rolling up the beach in the form of breakers.
5. Motion of distorted verticals.

All of these motions, except the last one mentioned, have at various times been proposed to be utilized for power purposes; while no attempts seem to have been made to utilize this last-mentioned motion, that of the distorted verticals, which seems the one by far most likely to give efficient results, as will be presently explained.

The most rational way of utilizing the vertical rise and fall of the particles at and near the surface, and the one almost invariably proposed, is by means of a heavy float. The float is either permitted to have a small amount of side motion, the extent of such motion being limited by the length of chains connecting the float to anchors, piles, or other fixed structures, or it is guided in a vertical straight line, or in the arc of a vertical circle. The float is usually hollow, being ballasted if necessary with rock or other heavy materials. It is usually rectangular and flat, or in the shape of a sphere, an ellipsoid, or a cylinder. In Fig. 1 is shown a simple case, the float being secured to a rope which is attached to one end of a walking beam, the other end of the latter being connected by a second rope to suitable mechanism for utilizing the power. As the float rises on the wave, the slack of its rope is taken up by suitable ratchet arrangements, and when the wave falls, the weight of the float is available for the production of useful work. In Fig. 2 the float is guided by guide rollers traveling along vertical piles. This float is provided with vertical straight racks which transmit their motion to pinions located on the structure above. The racks being rigid, power can be taken off on both the up and down strokes, though of course no increase of power is thereby gained over the simple scheme of taking off the power during the down stroke only. In Fig. 3 is shown a very simple device, a cylindrical float rising and falling on a central guide pile, the power being transmitted by means of vertical racks. A modification of this has the pump, which is operated by the rise and fall of the float, in the upper part of the guide pile itself, the object being to get all the principal parts as nearly as possible in line. In Fig. 4 is shown an ellipsoidal float, held at one end of a frame, the other end of which is pivoted to a rigid structure at some point above the water. The motion of the float is transmitted by a rope to suitable pumping mechanism. This device is practically employed at some points on the Atlantic coast to pump salt water for street sprinkling purposes. Fig. 5 shows a somewhat similar arrangement, the frame carrying the cylindrical float being pivoted below the surface of the water, and the shaft to which the frame is attached actuating suitable mechanism by means of a geared sector. This float is, in addition, provided with a curved lip to somewhat confine the water and thus get the full benefit of its momentum. In Fig. 6 is shown a spherical float attached to a rope leading downward. The actual rise and fall of the float causes a corresponding motion of the rope, which leads through a sheave below to proper mechanism on shore. The spherical float shown in Fig. 7 is anchored by means of a rope leading downward and through a sheave to the shore. As the float is forced upward by the rise of the wave, it is also compelled to approach the vertical line passing through the lower sheave, and thus causes a pull on the power rope, the power being thus transmitted by a sort of toggle-joint arrangement, the efficiency of which, to say the least, is doubtful.

The main objection to floats operated by this vertical motion of the water may be briefly stated. In the first place, the quantity of power that can be obtained by a float covering any given area of water, and rising and falling through a certain distance, is directly proportional to the weight of such float, as the number of foot-pounds of energy for each wave is simply the weight of the float in pounds multiplied by its rise or fall in feet.

With a wave of given height, then, the amount of power obtainable from such float can only be increased by increasing the weight of the latter. This weight may be increased in either of two ways.—(1) By making the float heavier per square foot of water area covered, as by using heavier material, or by increasing the amount of ballast carried. (2) By keeping the weight per square foot unaltered, but increasing the area of water covered by the float. Either of these methods is, however, attended with a loss of efficiency. An increase in weight of float means an increase in submerged depth and in inertia; and the inertia of such heavy float could not be overcome with sufficient rapidity to cause it to rise to the whole height of the wave, thus decreasing its efficiency. If, on the other hand, the float be made light to reduce its inertia, the possible amount of power to be transmitted thereby would again be correspondingly decreased. Furthermore, as the area of water covered by such float is made greater, the particles of water in contact with different points of its length would be in different phases, so that the mean rise of such water would be less. Thus it is evident that if the float were just half as long as the wave, it would have a tilting motion, but no rise or fall as a whole whatever; and if it were longer than the wave, practically no power at all could be obtained thereby. But as the length of the waves varies from day to day, a float which would be fairly efficient on one day with a certain series of waves might be utterly inefficient with a series of waves of a different length some other day.

The next motion to be considered is the horizontal to and fro motion of particles at and near the surface. The simplest arrangement for utilizing this motion consists in suspending a vertical flat vane from some point above the water, the lower end of such vane dipping into the water to a certain limited depth and being actuated by the horizontal component of the motion of the particles at and near the surface. Such arrangements are shown in Figs. 8 and 9, the vane in the latter actuating suitable mechanism by means of a connecting rod attached to its prolongation above the point of support, while in the former it operates a submerged pump directly, by means of a connecting rod attached to its lower end.

That some power can be obtained by these devices is beyond question, but their efficiency is hampered by the fact that while at first sight it would seem that the amount of power thereby obtained would, with a given breadth of vane, be directly proportional to the depth of immersion of the lower end of the vane, yet it is evident that the deeper the immersion of the vane the less efficient the apparatus would be. For the vane has an angular motion about its point of support, its lower immersed end moving through a greater distance than the portion at the surface of the water. But we have above seen that the horizontal motion of the particles is greatest at the surface and becomes less as the respective particles are further below the surface. The relative motions of the upper and lower portions of the vane are thus exactly the reverse of the natural relative motions of the particles of water in contact with those portions; so that as such vane extends deeper into the water, it becomes less efficient. If the vane be extended to the bottom, its motion would be much reduced in the case of a shallow water wave, and it would come to an absolute standstill in the case of the deep sea wave. Instead of the vanes just described, it has also been proposed to employ a float, rigidly secured to a long arm extending to and pivoted at some point of a fixed structure overhead or extending downward and pivoted at some point near the bottom of the water, but in each of these cases the utilization of the motion of the surface particles only is contemplated. A somewhat more complicated arrangement is shown in Fig. 10, in which a peculiarly shaped float is supported by crossed suspension rods. The longitudinal concavities of the surface of the float are alleged to be "of substantially the form the waves assume as they approach the shore, so that the full force thereof is utilized better than if sharp corners were presented."

In Fig. 11 is shown an arrangement of a cylindrical float, suspended by a number of ropes attached to the float at such points as to utilize not only the rise and fall of the float, but also the horizontal to and fro motion of the same. The extreme motion of the float is limited by chains attached thereto, as shown.

The next motion to consider is that due to the varying slope of the wave. In Fig. 12 is shown a float which lies on the wave and changes its inclination to the horizontal in accordance with the varying slope of the wave. A rigid arm is firmly secured to the float, extending across the latter; and ropes attached to the upper and lower ends of this arm transmit the power to mechanism on the shore or on a suitable structure erected in the water near the shore, the float itself being prevented from moving shoreward by an anchoring rope. The objections to this scheme are two-fold; In the first place, the curves in which the power ropes hang have different deflections according to the strain to which they are subjected. As the float becomes inclined by the action of the wave slope, the strain on one of the ropes increases, while that on the other decreases, the deflection of the former becoming less and that of the latter becoming greater; and the change in deflection corresponding to any increase in strain must be produced before the latter can be transmitted. The motion of the float must thus first take up a certain amount of slack in the rope, so as to decrease its deflection to that corresponding to the strain to be transmitted; but unless the waves were very steep, the motion of the float would probably hardly suffice to do more than take up this slack; and in such case no power, or at any rate very little power would be transmitted. This defect in the arrangement could, however, be much lessened by placing the float much nearer the structure supporting the mechanism, so that shorter ropes or even rods could be employed for transmitting the power. But there is another and more vital objection. To obtain the largest amount of power from this arrangement, the float should be exactly half the length of the wave. But as the waves vary considerably in length from day to day, it follows that the float, while quite sufficient in waves to which its length was suited, would lose efficiency among larger waves, and come almost to a standstill among much shorter waves.

Somewhat akin to the above is the device proposed

for employing the varying angle between two portions of the surface some distance apart in the direction of the length of the wave. It consists (Fig. 13) of two floats, preferably pontoons containing the mechanism for utilizing the power, these floats being hinged together so as to be capable of motion relative to each other about a horizontal axis. As the floats ride on opposite sides of the crest of a wave, their outer ends are lower than their inner ends, while in the trough of a wave this condition is reversed. The angular motion of the floats relative to each other is employed to operate a ratchet wheel as shown, from which the power is transmitted to any suitable mechanism.

The difficulty with this device is also due to the varying length of the waves from day to day. It is evident that if the length of the floats or pontoons be too short in comparison with the length of the wave, the angle between them will be very slight and but little power will be obtained. On the other hand, if they are too long, the angle is again diminished and the same difficulty presents itself. Thus a pair of such pontoons, of proper lengths to give their greatest efficiency for a certain length of wave, would be much less efficient for a wave one-half as long or double as long.

In Fig. 14 is shown an arrangement for utilizing all three of the motions above discussed. It consists of a rectangular float, surmounted by a framework rigidly attached to the same. A number of ropes are attached to various points of the float and of the framework as shown, leading over sheaves so placed that power will be transmitted not only by the rise and fall of the float, but by its tilting action on the slope of the wave, and by its horizontal to and fro motion. While superior, in some respects, to some of the simpler schemes above explained, it partakes of many of their disadvantages, and has the additional one of being somewhat more cumbersome and complicated.

Several radically distinct methods have been proposed for utilizing the impetus of breakers rolling up the beach. In Fig. 15 is shown a nearly vertical vane held in a framework which is provided with wheels at the bottom and with ropes leading to suitable mechanism on shore. These wheels run on rails laid down the slope of the beach, or may even run on the slope of the beach itself, if the latter be hard and smooth. As the breaker strikes this vane, it drives it rapidly up the slope of the beach, and the slack of the rope is taken up by suitable ratchets or other contrivances. As the water recedes, the weight of the vane and carriage causes the latter to run down the slope of the beach, and useful work may be performed by utilizing the pull on the rope. Some little difficulty would probably be experienced with this apparatus on account of the sand filling in along the track, which would probably finally result in throwing the apparatus off the track. It labors under the disadvantage that much of the inherent energy of the smooth waves is dissipated in the eddies of the breakers before it reaches the vane, and that the delivery of the energy of the breakers to the vane by what would practically be a sharp blow is naturally much less efficient than in cases where this transfer of energy is more gradual.

An entirely different method is shown in Fig. 16. The mass of water is allowed to enter a large strongly built chamber, which decreases in both height and width toward its shoreward end. At this end a non-return valve (a) is provided, beyond which is a closed chamber. In the top of the latter is the non-return valve (b), above which is an air chamber and a pipe leading to the water reservoir. When the wave enters the receiving chamber it has a certain velocity; and as the cross-sectional area of this chamber becomes less, the velocity of the water must increase until at the inner end it becomes sufficient to pass through the non-return valves (a) and (b), against the pressure due to the height of the water in the reservoir. While this apparatus has the advantage of simplicity and few working parts, it labors under the disadvantage that much of the energy of the waves is dissipated by the time they reach the apparatus. There is also much internal friction and great liability to filling up with sand. It has the further disadvantage of not being adjustable to rise and fall of the tide or the condition of the sea.

Taking up again the theory of wave motion, the author explains the "motion of distorted verticals" and why this motion is best suited for utilization as a source of power. In Figs. 17, 18 and 19 he shows three types of wave motors designed to utilize this motion, the motor consisting in each case of a thin vane, extending from above the surface of the water to near the bottom, and suspended in various ways, according to the depth of the water and the variations in magnitude and direction of the waves. It will be noted that these motors are designed to utilize both the to and fro motion of the vane as a whole, and also its motion from a vertical plane to an inclination in either direction. The motor shown in Fig. 19 is, the author says, of most general application. He describes the details of the mechanism as follows:

In order to adjust the vane (B) about a vertical axis to suit the direction of the waves, there is provided in each of these arrangements a turn-table (T), which, by means of suitable mechanism, is turned and adjusted to any desired position and properly secured after adjustment. The turn-table supports and carries with it the bearings, the vane, and all other necessary parts. This turn-table may be dispensed with when the contour of the coast or other influences cause a practically constant direction of the waves.

(C, D) etc., are firmly braced structures supporting the platforms or floors (E) and (F), the turn-table (T), and the vane (B). On these platforms or floors, or

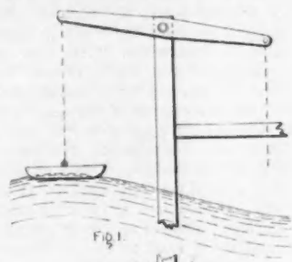


Fig. 1.

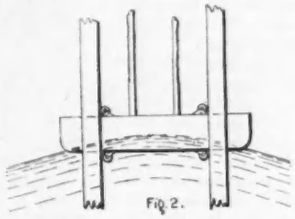


Fig. 2.

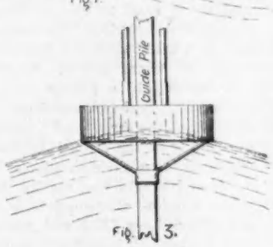


Fig. 3.

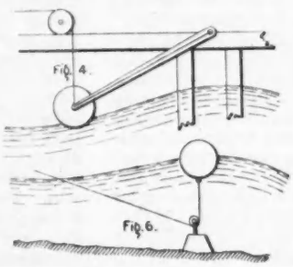


Fig. 4.

Fig. 6.

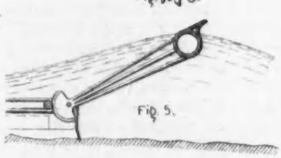


Fig. 5.

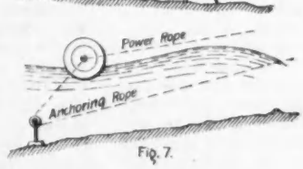


Fig. 7.

MOTORS OPERATED BY RISE AND FALL OF FLOAT.

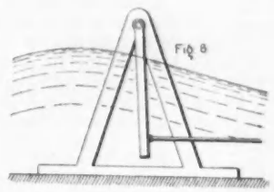


Fig. 8.

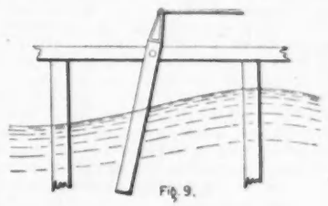


Fig. 9.

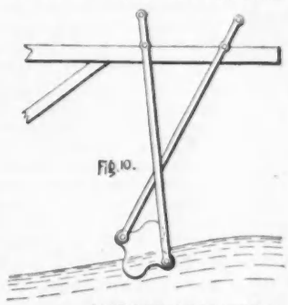


Fig. 10.

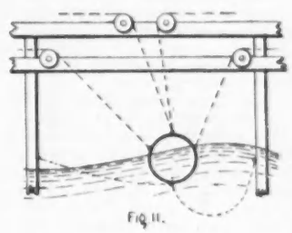


Fig. 11.

MOTORS OPERATED BY TO AND FRO MOTION OF WAVES.

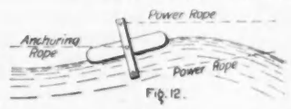


Fig. 12.

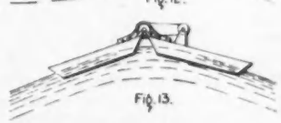


Fig. 13.

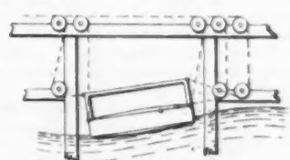


Fig. 14.

MOTORS OPERATED BY VARYING SLOPE OF WAVE SURFACE.

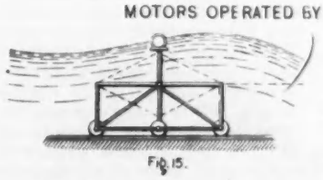


Fig. 15.

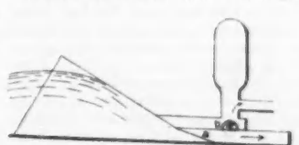


Fig. 16.

MOTORS OPERATED BY IMPETUS OF WAVES ROLLING UP BEACH.

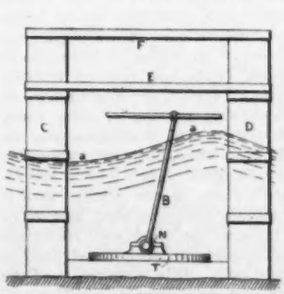


Fig. 17.

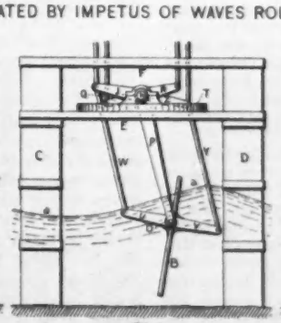


Fig. 18.

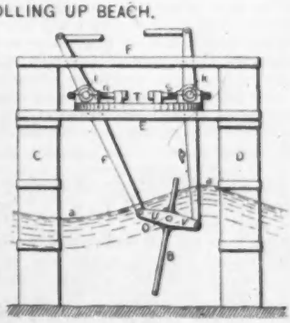


Fig. 19.

MOTORS UTILIZING MOTION OF DISTORTED VERTICALS.

within the structures (C, D), etc., can be placed the pumping or other mechanism for transmitting, utilizing or storing the power derived from the waves by the vane, and the mechanism for adjusting and securing the turn-table. In practically building these structures it would probably be found best to make their lower portions closed, so as to be filled with concrete or other heavy material, while their upper portions would be open lattice-work, so as to interfere as little as possible with the movement of the wave.

The energy of the forward vibration of the distorted verticals is greater than that of their backward vibration; and the vane will thus not vibrate equally in both directions if the same resistance is opposed to it during both vibrations. The proper and regular working of the vane can be ensured either by opposing a suitable smaller effective resistance to the motion of the vane during the backward than during the forward vibration, or by opposing to the forward vibration of the vane, in addition to the equal effective resistance opposing both vibrations, a suitable additional resistance so arranged as to yield up, during the backward vibration, the potential energy thereby stored up during the forward vibration. The former method simply requires that the amount of power derived from the vane on the forward and backward vibrations, respectively, is to be adjusted to correspond to the normal energy of the distorted verticals during these respective vibrations. The latter method is most simply carried out by the raising of a free weight or the extension or compression of a spring during the forward vibration, the potential energy of which is then allowed to assist the backward vibration. The irregularity of the vibrations which would be induced by a current can be rectified in a similar manner.

As the motion of these vanes, arranged as above proposed, conforms very closely to the natural movement of the distorted verticals, the elements of inefficiency which have been pointed out with reference to some of the previously described methods are very much reduced or even altogether absent. The action of the vane is more nearly akin to that of the piston of a steam engine, being driven forward and backward by the variations of the fluid pressure on its faces. Its weight does not affect the amount of energy, except as a slightly prejudicial factor, which should be kept as low as possible. The vane is therefore made as light and thin as considerations of strength and rigidity will permit, thus reducing the loss of efficiency due to its inertia, and at the same time reducing to the least possible amount its interference with the normal structure and movement of the wave. A notable feature about these proposed vanes is that increase of immersion is accompanied by increase of efficiency; and this is a very important point of difference between them and certain other apparatus already described. The greatest efficiency for any particular series of waves will be obtained by letting the vane extend from the surface of the wave crest to the bottom of the water; and, provided the vane is long enough to reach to the top of the highest wave crest which it is desired to utilize, the efficiency of the apparatus will not be affected by variations in the magnitude of the waves.

To accommodate themselves to variation in height of tide, most of the arrangements above discussed are raised and lowered bodily the required amount. Some of the floats are thus adjusted by simply shortening or lengthening the power ropes, which can readily be done; the floats that describe vertical arcs or circles adjust themselves by simply describing an arc which is higher up on their circle of motion; the floats describing horizontal arcs of circles and most of the vanes require their points of suspension or support to be adjustable in a vertical direction. The vanes proposed in this paper require no adjusting, being made of such length that they are long enough to reach the wave crests at high tide, while at low tide their upper ends simply project above the water.

To prevent damage to the apparatus in a heavy storm, some of the motors are located in enclosures, the gates of which may be closed in bad weather, and others are arranged to hoist out of the water altogether. But as the energy of the waves is very much greater during a storm than with an ordinary swell (see table of HP. above given), it hardly seems wise to throw motors out of action at a time when they could develop the most power. We propose, therefore, to make our vanes of such length that they will reach to the top of the largest waves that can be faced with the strength of the vanes as constructed. When the size of the waves increases beyond this limit, and huge breakers come rolling in, the crests of the latter will be considerably above the upper ends of the vanes, so that the vanes will not be injured by the breaking of these crests; and as the motion of the water rapidly decreases below the surface, we consider that our proposed vanes may safely work in any weather, being entirely below the reach of the breaking crests of the waves in a heavy storm, while they project up through the wave crest in ordinary weather.

The author then takes up what is apparently the most difficult problem of all in connection with any considerable utilization of wave power, the necessity of providing a large storage of power for use during long continued calms. After discussing compressed air tanks and storage batteries, he concludes that pumping water to an elevated reservoir is the system of power storage which offers on the whole the most advantages and seems best adapted for use in connection with a wave motor. As an example of what would be required in practice, he supposes a reservoir at an elevation of 340 ft. above the water-wheel. If the water is used with an efficiency of 80%, the discharge will be 2,122 cu. ft. per minute per horse power. If we assume that power is required for 10 hours daily, and that the reserve of power must be sufficient to last through a ten days' calm, then a reservoir to furnish 100 HP. would have to be 20 ft. deep and 252 ft. square.

Although the author gives these figures to show the feasibility of the use of wave motors, they serve really to make very doubtful the use of wave motors for general power purposes, even under the conditions of dear fuel which exist on the Pacific slope. On the other hand, for uses where an intermittent action is admissible, such as pumping water for flushing sewers, street sprinkling, irrigation, drainage, etc., there seems to be considerable opportunities for the successful use of wave power.

In this connection it occurs to us that the irregularity, which is the chief difficulty in utilizing wave power, could be partially obviated by combining the use of wind and wave power. By erecting a windmill in connection with a wave motor, both storing power by pumping to an elevated reservoir, the probabilities of both motors being idle during any considerable time would be much reduced. It is true that calm seas and still air frequently accompany each other; but on the other hand, the ocean is often fairly quiet when a strong breeze is blowing offshore, and vice versa, a heavy swell is frequently rolling in when no wind is blowing.

THE CESSNOCK DOCKS, GLASGOW.

The following description of the new docks at Glasgow, Scotland, is taken from "Industries," London. The three main basins are parallel with the River Clyde, and separated by piers about 250 ft. wide. Ships entering from the river come into the canting basin, which is at right angles with the river and from which the main basins open. The foundations consist of hollow concrete cylinders built up to form a concrete base, perforated by "wells." The material within the cylinders or wells is removed by a clamshell dredge, and the cylinders then filled with Portland cement concrete.

The trustees of the Clyde Navigation, finding that the dock accommodation at Glasgow was rapidly becoming insufficient for the trade of the port, decided in 1882 to go to Parliament for an act to construct new docks on the south side of the river Clyde, inclose a larger water area and provide greater quay space than either of the two other wet docks at Glasgow. The act for the construction of new docks, to be called the Cessnock Docks, was passed in 1883, but construction was not begun until 1886. The estimated cost of the works was $7,500,000, exclusive of the value of 100 acres of land. The Cessnock Docks are situated between Glasgow and Govan, and their construction as authorized involved the erection of two swing bridges and a bifurcated road to carry across the entrance the main road with the tramway line between Govan and Glasgow. After mature consideration the trustees came to the opinion that it would be better for all concerned that, instead of the two swing bridges, the road and tramways should be carried around the docks, and the entrance left perfectly open. This modification of the design, after strenuous opposition by the Commissioners of the Burgh of Govan, was sanctioned by Parliament in 1890. The new road is 1,565 yards in length and 60 ft. in width, the pavement being 12 ft. 6 in. wide on each side, having a clear roadway of 35 ft. Access to the new docks will be obtained by means of a dock railway, which will be connected with the Glasgow & Paisley Joint Line system at Ibrox Station, and will pass under the new road by a skew bridge, consisting of steel girders with Hobson's patent arch plate system of flooring. In addition to the diversion of the main road, it was also necessary to construct an intercepting sewer along the center line of the road. This sewer ranges from 4 ft. 6 in. to 3 ft. in diameter, and is 5,154 ft. in length.

The Cessnock Docks when complete will consist of three main basins and one canting basin. The total water area will be 34 2-3 acres, and the total length of the quay wall will be 11,289 lineal feet. There will also be a dry dock, which branches from the entrance to the Cessnock Docks, and will be one of the longest and widest in the kingdom. The graving dock will have a length of 900 ft., a width of 83 ft. in entrance, and a depth of 26 ft. on the sill at high water of ordinary spring tides.

The north basin of the wet dock was the first of the system to be constructed. The quay wall is now practically completed, and the work of dredging out the material between the walls is begun. The soil in which the excavation of the dock has been made is composed almost wholly of sand with occasional pockets of clay, and its nature permitted the adoption in the construction of the quay walls of the method successfully adopted in the case of the Queen's Dock—viz., the principle of triple-concrete cylinders as a substructure. These cylinders are made in rings 2 ft. 6 ins. deep by 1 ft. 11 ins. thick, in movable wooden molds, on a platform. The concrete employed consists of five of gravel or broken stones and sharp sand to one of Portland cement of the strongest description. The materials are mixed together in a mixer designed for the purpose, and actuated by steam power. Water is added to bring the mass into a plastic state. In order to facilitate handling, and to break bond when built, the rings are divided into three and four pieces alternately. The dividing of the rings is effected in the molds by malleable iron division plates ⅜-in. thick. These are placed across the wooden molds in the proper positions before the concrete is filled in. After the molds have been filled with concrete, the material is well hammered, in order to secure a homogeneous structure and a smooth surface. In twelve hours the division plates are withdrawn, and two days afterward the wooden molds are removed. The rings are ready for removal after a period of from nine days in dry hot weather to three weeks in wet or cold. The cubic contents of one ring complete is 10½ cu. yds., and the weight is 18 tons, the heaviest portion being about 6 tons. Each of the cylinders is composed of 14 rings, and is 36 ft. 6 ins. in height. The lowest ring is slightly different from the others. It is rather thinner at the bottom, and is fitted into a cast iron shoe. The shoe is 2 ft. deep, is made of 1 in. metal, and is of the same size and shape externally as the rings. The under side of the bottom ring rests on a shelf in the shoe, about 6 ins. below its top edge. This shelf is formed of an inner ring of cast iron 1 in. thick projecting at the top 12 ins. inward, and tapering outward to the bottom of the shoe, where it joins the outer ring, thus forming a cutting edge to the shoe, the wedge-shaped space between the outer and inner rings being filled up with concrete. The shoe weighs about 4 tons 10 cwt., and, for convenience in placing in the trench, is made in six parts. The method of construction is to cut a trench along the line of the proposed quay wall. The bottom of this trench is about 2 ft. below low-water level, where it is made 21 ft. wide, the sides of the trench sloping upward with a batter of 1½ horizontal to 1 perpendicular. The necessary staging to carry the traveling cranes and digging apparatus is erected at the side of the trench. At the bottom of the trench the shoes are placed exactly in the line of the quay wall; the space between the outer and the inner rings of the shoe is filled up with the concrete. The lowest or "corbelled ring" is placed on the shelf in the shoe and bolted to it by thirteen 1¼-in. bolts, a malleable iron ring 5 ins. by ½ in. thick being sunk into the corbelled ring on the top, the place for this ring and for the bolts passing through the concrete ring having been made in the molding of the latter. The remaining thirteen rings forming the cylinder are set one on the top of the other, in Portland cement, in three or four pieces alternately, so as to break bond, as already explained. The cylinders, in groups of three, are placed in the trench so as to dovetail into each other, one in front and two behind, and two in front and one behind alternately, the sides of the groups, where they press against each other, being flattened for a length of 5 ft. in order to in-

sure a good bearing. When the building up of the rings forming one group of cylinders is completed, the sand and gravel are dug out from within each of the three cylinders by means of excavators specially designed for that purpose. From 400 to 450 tons of cast iron weights of the same shape as the rings are generally required to force each group of cylinders down to the proper depth, which is 55 ft. below the cope level of the quay, the tops of the cylinders finishing about 9 ins. above low-water level. The average rate of sinking is about 12 ins. per hour. In good working sand as much as 3 ft. per hour has, however, been attained. When the group has been sunk it is cleaned out by means of excavators to the level of the bottom of the shoe, and each cylinder is then filled to the top with Portland cement concrete, and on this foundation the quay wall is built. The walls are of concrete rubble, many of the stones weighing two to three tons each, faced with concrete ashlar in courses ranging from 18 ins. to 15 ins. in thickness, the blocks being not less than 4 ft. long by 2 ft. broad in the beds, and the headers not more than 10 ft. apart at centers. The cope is of granite, 3 ft. 6 ins. broad by 15 ins. thick, in lengths not less than 4 ft., and the mooring bollards, which are 64 ft. apart at centers, are built into the wall immediately behind the cope. In order to close up the apertures formed by joining the groups of cylinders in an effectual manner, a timber chock-pile, 30 ft. long by 11 ins. square, is driven behind angularly, so that a sharp corner may bear hard against the cylinders. (The digger employed in excavating the soil from the interior of the cylinders is a clamshell dredge.—Ed.)

In order to strengthen the end wall of the north pier, where a pocket of soft clay was met with, twin cylinders were employed in addition to the triple cylinders, thus giving a series of five cylinders in the wall. The triple cylinders were sunk in front and the twin cylinders behind, the two series being bound together at the top by old iron rails. This increase in the breadth of the base permitted a proportionate increase in the breadth of the superstructure, which was thus increased from 16 ft. to 26 ft. The plan of employing twin cylinders behind the triple cylinders to give greater stability will be adopted also in the construction of the west wall of the docks, for in front of this wall there will be a depth of 28 ft. at low water.

The north quay wall of the north basin is 1,676 ft. long and 90 ft. wide. Along this quay there is in course of erection a line of two-story sheds 70 ft. wide. The upper story will be used for receiving inward cargo, and the lower story will be used for receiving outward cargo. The sheds consist of a back wall of mason work, and of a front and middle row of steel columns, with sliding blinds in front and numerous openings behind, so that cargo may be taken in or out of the shed at any point in its length. There is a space in front of the shed of 20 ft. for the erection of cranes. The sheds are being erected under contract by Messrs. P. & W. Maclellan. It has been decided to erect similar sheds on the south quay of the north basin.

The Cessnock Dock system will give a depth at low water of ordinary spring tides of 25 ft., and at high water of ordinary spring tides of 36 ft., with the exception of the west wall of the dock, which will have a depth at low water of ordinary spring tides of 28 ft., and at high water of 39 ft. The canting basin is 700 ft. by 685 ft. Two of the three basins will be each 200 ft. broad, and the remaining basin will have an average width of 220 ft.; the two piers separating the basins will be 250 ft. wide. On the west quay wall of the dock will be constructed a steam crane capable of lifting 120 tons. Here also will be the deepest berth in the dock.

The docks have been constructed by and from the designs of Mr. James Deas, engineer to the trustees of the Clyde Navigation, who also designed the Queen's Dock. The resident engineer of the Cessnock Docks is Mr. A. Hamilton. It is expected that a portion of the dock will be ready for use in December next.

ROADS IN BOHEMIA.

The following interesting particulars respecting the construction and management of public roads in Bohemia are taken from a report by Mr. J. B. Hawes, United States Consul at Reichenberg:

Public streets and roads which are not supported by the government treasury are divided into country roads, district roads and parish roads. Country roads are those so declared by law on account of their importance; district roads are those so declared by the district authorities, or, in special cases, by the government authorities; parish streets or ways are all other open thoroughfares which belong to neither of the above classes and are not private property. Bridges and other artificial works belong to the roads in which they lie, unless, on account of great expense or importance, it is decided otherwise.

The cost of the creating and keeping up of country roads is borne by the country fund. Whether a district through which a country road runs shall participate in the expense and the proportion thereof is decided in each case. Expenses of district roads shall be met by the district authorities. Expenses, when not otherwise provided for, belong to the district. The expenses for building or maintaining, especially expensive district or parish roads, may be paid from the district or country fund, as decided by the authorities. If the inhabitants of a village desire that a road should run through their village which would otherwise only pass the place, the village must pay the extra cost. If such a village collects toll for the pavement or a bridge the village has to provide for the maintenance of the thoroughfare.

Snow-cleaning of the country or district roads must be done by that parish located not more than five miles from the road. The district and country authorities determine which parish shall do it, and also fix the compensation for the work. Snow-cleaning of the country roads in the village is to be done by the parish; exceptions are sometimes made in cases where a village is spread over a great territory. The management of the construction and maintenance of country roads should belong to the country authorities, but this is usually transferred to the district authorities.

Every country road collects toll. District roads collect toll only when they are supported by the country fund. Parish roads usually collect no toll. Permission to collect such toll is occasionally granted, however, on account of unusually expensive maintenance of the road. Bridges usually collect no toll, but exceptions may be granted by the country authorities.

Country roads are under the supervision of the country authorities, the district roads under that of the district authorities, and parish roads under that of parish authorities. The whole or part payment of the expenses for district or parish roads out of the country fund can only be granted for such roads as are especially important for the traffic of the whole country. The expenses for country roads are paid from the country fund.

The width of country roads, excluding the ditches, is 21.3 to 24.6 ft., according to the traffic. The width of the foundation is 14.76 to 16.4 ft., the depth 10 to 12 ins. Upon this is placed a layer of broken stone of the same width and a depth of 4 to 6 ins. The whole is covered with coarse sand or gravel from 1¼ to 2 ins. deep. The bottom of the ditches is 1.64 ft. broad, and the slope of the sides is from 30° to 35°. Roads of 21.3 ft. must have a convexity of 6 to 8 ins., and those of 24.6 ft. width a convexity of 8 to 10 ins. The maximum ascent should only be 5 per cent., and, in case of very unfavorable territory, shall not exceed 6 per cent. Heavier grades are only allowed over mountain roads, and then shall not be more than 328 ft. in length.

The width of district roads, excluding ditches, is 19.68 to 21.3 ft., according to traffic. The foundation is 13 to 16½ ft. broad and 8 to 10 ins. high. Upon this is placed a layer of broken stones of the same width and 3¼ to 4 ins. high. The whole is covered with rough sand or gravel. The bottom of the ditches should be about 16 ins. broad and the slope of the walls 35° to 45°. The convexity of roads of a width of 19.68 should be 4 to 6 ins. and that of roads of 21.3 ft. 6 to 8 ins. The grade must not exceed 6 per cent., or, if the locality is unfavorable, 8 per cent. Heavier grades are only allowed in extremely unfavorable localities and where roads are to be used by light vehicles only. This is decided by the country authorities.

If the stones used are especially dear, or when it proves otherwise advisable, then the road may be macadamized. In this case the broken stones are piled up and rolled until the pavement of country roads reaches a height of 10 to 12 ins., and that of district roads 8 to 10 ins. On both sides of the macadamized roads must be placed large stones to prevent the broken stone being pushed aside when rolled. The whole road is then covered with rough sand and must be wet and rolled until it is level and hard. If a road runs through a village and cannot, on account of local conditions, have the width as above stated, then paved gutters may be substituted for the ditches.

Highways must be provided with stone posts to prevent driving off dangerous places. They must be 3¼ to 4 ft. high and 5⅛ to 8 ft. apart. If the roadbed is very high or runs alongside of a river or ravine, they must be placed 3¼ to 5⅛ ft. apart. Strong railing may also be used, or trees will meet the requirement if they have a thickness of 3½ to 4 ins.

The country authorities authorize the district board to supervise the country roads, and the district board authorizes one or several of its members to watch the maintenance of the road. These members must report as to the condition of the road in the meeting of the district board. In important matters the decision of the country board should be demanded by the district board. The district board has further to ask the approval of the country authorities in any conclusion at which they may arrive. The district board must prepare estimates of the expenses for the coming year and submit them to the country authorities.

Parliament fixes the amount for building and maintaining country roads. The amount is based upon the expense of former years, and the country authorities notify the various districts of the amounts allotted to them, at the same time opening credits at the Imperial and royal tax offices. The country authorities also sometimes give directions as to how the money shall be expended. In all cases where technical knowledge is required the district board must engage a person versed in such matters, in order to assist such members as are in charge of the country roads. The selection of such person must be approved by the country authorities, who also give him the necessary instructions and provide for his salary. Men are employed to keep the roads in good repair, each man having charge of a distinct part of the road, usually 1.6 miles. These men must be on duty during the daytime and keep the footpaths and ditches free from grass, stones, etc. Grass growing in the ditches may be sold for the benefit of the fund for road maintenance, but ditches must not be used for pasturage. Stones to be used during the year must be delivered in the fall; they are piled up on one side of the road to be later broken. They shall be used in fall or spring, or, if absolutely necessary, also in summer. Before stoning the road it must be first cleaned of mud. The stoning should be done in damp weather and only for short distances at a time. The parts of the road so stoned should immediately be covered with sand or gravel. Roads should be rolled each year to make them hard.

District roads are under the supervision of the district board, which is responsible for their good condition. A certain number of workmen must be engaged to keep in order those district roads which are supported by government funds or those which collect toll. The district authorities must report at the end of each year as to the length of new roads built, the cost of maintenance of the district roads, and how much toll has been collected; also the number of trees planted on such roads, in order to enable the country authorities to make up complete and reliable maps. The management of the parish roads is in the hands of the parish authorities, who are obliged to keep them in good order, especially those which connect various villages.

In order to prevent roads from being ruined, only brakes and drags are allowed to be used on vehicles. Drag chains must never be used; "plow drags" and trunks of trees used as drags may only be used when snow is on the ground. All roads must have trees on both sides, and the law prescribes that trees with broad-spreading branches shall be chosen.

The cost of constructing country roads is from $2.28 to $4 per meter, varying greatly in accordance with difficulties encountered, distance from source of supply of material, etc. In this neighborhood the stone used is basalt, which is admirably adapted for road-making.

In this industrial neighborhood, where heavy drays loaded with merchandise are constantly passing, all of the pavements are made of granite blocks set on a sandy bed. The cost of paving the streets of Reichenberg per sq. meter is about as follows:

Leveling the ground	$.12
¾ blocks, at 6½ kreutzers each	.88
Sand	.08
Labor	.20
Total	$1.28

This seems to be a very fair average, as the cost of similar stone pavement in Kratzau, a neighboring town of 3,600 inhabitants, is $1.21 per sq. meter.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Neglect to Block Frogs.

The laws of Michigan make it unlawful for railway companies to neglect to so block the frogs on their roads as to prevent the feet of employees from being caught therein. In an action by a switchman for personal injuries, it appeared that while uncoupling cars he was injured by reason of an unblocked frog. There was evidence that other frogs in the yard were unblocked, and that the yard master had been notified of their condition some time before the accident; that the frog in question had been unblocked at least two months. It was no defense in such action that the company had employed men to see that all the frogs were kept blocked, and that proper material was furnished for that purpose, since the negligence of the employees in that respect was the negligence of the company. (Ashman vs. Flint & P. M. Ry. Co., Sup. Ct., Mich., 51 N. W. Rep., 645.)

STATISTICS OF THE AMERICAN AND FOREIGN IRON TRADES FOR 1891.

The annual statistical report of the American Iron and Steel Association, which has recently been issued, states that the year 1891 was one of very great reaction in the United States, and in almost every other country, from the activity of 1890. The production of manufactured goods was seriously interrupted and prices were low all through the year. The present outlook is said to be still unsatisfactory, although not positively discouraging. Production is still restricted in many manufacturing industries, and prices refuse to advance. From January to June, 1891, there was a general stoppage of operations at the blast furnaces in the Shenango and Mahoning valleys, as the result of an agreement among the owners to restrict the production of pig iron. From February to May a strike checked the production of coke in the Connellsville region, but in spite of these two checks in production, the prices of iron and steel did not advance, although the consumption throughout the remainder of the year was active, except in steel rails. This is largely accounted for by a greatly increased production during the latter half of the year, and which continued for the first three months of the present year. In January, 1892, the depression in the iron trade was emphasized by a serious break in the prices of structural material, and in February there was a break in the price of barbed wire. In both cases the prices had been maintained by artificial methods; but the pressure of competition could not be resisted. In February, also, there was a break in the prices of Bessemer pig iron and steel billets at Pittsburg. Southern competition presses heavily upon the pig iron manufacturers of the North and West, and low prices are expected to continue, except possibly for Bessemer pig iron, which the South does not produce in large quantities.

One of the most discouraging features of the iron trade in the past year, and during the early months of 1892, was the greatly decreased demand for steel rails for either old or new railways. The production was more than half a million tons less than in 1890. According to Mr. Poor the mileage of new railway built in 1891 was only 4,262 miles, as against 5,739 miles in 1890, and managers also felt compelled to practice the strictest economy in the purchase of rails and rolling stock. Among the reasons for the decrease in mileage of new railways are the absence of foreign capital, the disturbing political influence known as the Farmers' Alliance, and also the warning conveyed in the unprofitable character of many railway enterprises which have been projected and completed in the last few years. The building of locomotives by private establishments was less in 1891 than in 1890, and would have been still less but for a great increase in the export trade over that of the earlier year. The number built by 15 establishments in 1891 was 2,300, of which 357 were exported, against 137 and 187 exported in 1890 and 1889. The total number of freight cars built by private works was 103,774, as against 96,277 in 1890. The iron and steel vessels of the merchant marine which were launched from American shipyards, including vessels built on the great lakes, numbered 76, with an aggregate gross tonnage of 105,618 tons. This was by far the largest annual tonnage in our history, exceeding that of 1890, the next largest year, by 13 vessels and 25,240 tons. Among the favorable signs for more activity in several branches of the home iron trade, are the firm prices at which steel rails are still held, and the prospect of a large business in the building of locomotives and cars. On the other hand, it is said to be somewhat discouraging to learn from the statistics compiled by the association that there has been a considerable increase in the unsold stocks of pig iron, amounting on April 1 to 718,579 gross tons, against 596,333 tons on Dec. 31, 1891. The imports of iron and steel declined over 100,000 tons in 1891 as compared with 1890.

Table No. 1, which we have slightly modified from tables in the report, gives in the first five columns the average yearly prices of certain iron and steel articles, and in the last three columns the lowest quoted prices in each of three periods of very low prices in this country. The quotations are per gross ton, except per 100 lbs. for bar iron and per keg of 100 lbs. for nails.

Table No. 1.—Iron and Steel Prices.

	Average Prices.				Lowest Prices.		
	1887	1888	1889	1890	1891	1873-9	1884-5	1891-2
Old iron T-rails at Philadelphia	$22.97	$22.23	$24.19	$25.18	$22.05	$18.00	$16.50	$20.00
No. 1 anthracite foundry pig, Philadelphia	20.92	18.88	17.73	18.40	17.52	16.50	17.50	16.00
Gray forge pig iron, at Philadelphia	17.79	16.21	15.48	15.82	14.52	....	....	....
" " " Lake ore mixed, at Pittsb'g.	19.02	15.99	15.27	15.78	14.06	16.00	14.00	13.00
Bessemer pig iron, at Pittsburg	21.37	17.38	18.00	18.85	15.95	19.50	17.00	14.00
Steel rails at mills, Pennsylvania	37.08	29.83	29.25	31.75	29.92	40.00	26.00	30.00
Best refined bar iron from store, Philadelphia	2.20	2.01	1.94	2.05	1.90	....	....	....
All muck-bar iron, at Pittsburg	1.95	1.77	1.71	1.85	1.71	....	....	....
Best bar iron, at Pittsburg	....	....	....	....	....	1.60	1.50	1.60
Cut nails, at Pittsburg, base price	2.15	1.90	1.99	1.99	1.58	1.90	2.00	1.50

The total quantity of tin plate imported in the 21 years covered by Table No. 2, was 3,950,721 gross tons, with a total foreign value of $333,241,709, in addition to which our people paid freight, duties and importers' profits. The imports are all from Great Britain, and comprise annually about three-fourths of her total exports. Since the beginning of 1892 the imports have sensibly increased, the stocks accumulated before July 1, 1891 (when the new duty of 2.2 cts. per lb., instead of 1 ct. per lb., went into effect), as well as subsequent importations, having been largely disposed of. In the first quarter of 1892 the imports exceeded those of the same period of 1890 by over 5,000 tons, but were less than those of the same period of 1891 by over 34,000 tons. The active steps which are now being taken to build up a tin plate industry in this country will probably greatly reduce tin plate imports:

Table No. 2.—Tin Plate Importation.

Years.	Tons.	Values.	Years.	Tons.	Values.
1871..	82,969	$9,946,373	1882..	213,987	17,975,161
1872..	85,629	13,893,450	1883..	221,233	18,156,775
1873..	97,177	14,240,508	1884..	216,181	16,858,650
1874..	79,778	13,057,658	1885..	228,596	15,991,152
1875..	91,054	12,098,885	1886..	257,822	17,504,976
1876..	89,946	9,416,816	1887..	283,836	18,099,145
1877..	112,479	10,679,028	1888..	298,238	19,762,961
1878..	107,864	9,069,967	1889..	331,311	21,726,707
1879..	154,250	13,227,650	1890..	329,435	23,670,158
1880..	158,049	16,478,110	1891..	327,882	25,900,305
1881..	183,005	14,886,907			

In Table No. 3 is shown the total value of our export trade in iron and steel and manufactures thereof since 1870, which has increased pretty steadily.

Table No. 3.—Iron and Steel Exports.

Years.	Values.	Years.	Values.	Years.	Values.
1871..	$14,185,359	1878..	$15,101,899	1885..	$16,422,511
1872..	12,595,539	1879..	14,223,646	1886..	14,895,087
1873..	14,173,772	1880..	15,156,703	1887..	16,235,922
1874..	17,312,239	1881..	18,216,121	1888..	19,578,480
1875..	17,976,833	1882..	22,348,834	1889..	23,712,814
1876..	13,641,724	1883..	22,716,040	1890..	27,000,134
1877..	18,549,922	1884..	19,290,895	1891..	30,736,442

The total production, in gross tons, of pig iron in the United States and Great Britain in 1890 and 1891 was as follows:

	1890.	1891.	Decrease.
United States	9,202,703	8,279,870	922,833
Great Britain	7,904,214	7,228,496	675,718

The decreased production in the United States in 1891 was chiefly borne by Pennsylvania, Ohio, West Virginia, Missouri and New Jersey, which in the aggregate lost 838,211 gross tons out of a total loss of 922,833 tons. The production of pig iron in the Southern States had a slight decline, being 1,708,966 gross tons in 1891, against 1,744,160 tons in 1890. There was a decrease in the production in every district of Pennsylvania in 1891 as compared with 1890, with the exception of Allegheny Co., in which there was a very large increase. The consumption of pig iron, in gross tons, for the last five years was as follows:

1887.	1888.	1889.	1890.	1891.
6,808,386	6,688,744	7,768,666	8,959,679	8,381,674

Table No. 4 shows the total production in gross tons, according to fuel, in 1887 and 1891:

Table No. 4.—Pig Iron Production according to Fuel.

	1887.	1891.
Bituminous, chiefly coke	3,813,067	5,836,799
Anthracite and coke mixed	1,713,964	1,560,282
Anthracite alone	373,883	305,826
Charcoal	516,234	576,964
Total	6,417,148	8,279,871

At the end of 1891 the total number of furnaces which were active, or likely to be some day active, was 569, and 11 new furnaces were in course of erection. On March 31, 1892, there were 279 furnaces in blast. Table No. 5 gives the number of furnaces in blast, classified according to fuel:

Table No. 5.—Furnaces in Blast.

Fuel	1887	1888	1889	1890	1891
Bitum. coal and coke	147	156	177	150	164
Anthr., and anthr. and coke	118	105	104	97	94
Charcoal	74	71	63	64	55
Total	339	332	344	311	313

Table No. 6 gives the total production of steel, of rolled iron and steel, and of rails, etc. Of the total production of rails in 1891, Pennsylvania made 69% and Illinois 28%. The production was made up of 1,239,393 gross tons of Bessemer steel rails, rolled by the producers of domestic ingots, 53,660 tons of Bessemer steel rails rolled from purchased blooms and from old steel rails, 5,833 tons of open hearth steel rails, and 8,240 tons of iron rails; nearly all street rails are now rolled from Bessemer steel:

Table No. 6.—Steel and Iron Production.

	1890.	1891.
Total steel	4,277,071	3,904,240
Bessemer, incl. C-G	3,688,870	3,245,631
Clapp-Griffith	68,741	65,388
Rolled iron and steel	6,022,875	5,390,963
Bessemer steel rails	1,867,857	1,293,053
Street rails	98,529	81,292
Total rails	1,885,307	1,307,176

The statistics of nail production show a steady increase in the use of wire nails, as will be seen from the following figures, which are kegs of 100 lbs:

	1888.	1889.	1890.	1891.
Cut nails	6,493,591	5,810,758	5,640,946	5,002,176
Wire nails	1,500,000	2,435,000	3,135,911	4,114,385
Total	7,993,591	8,245,758	8,776,857	9,116,561

The next interesting point is that of iron and steel shipbuilding, which shows an increase of from 7 vessels aggregating 5,927 gross tonage in 1877 (all steamers), to 76 vessels (all steamers), aggregating 105,618 gross tonnage in 1891. Table No. 7 gives the statistics of ship building in the United States and Great Britain, by which it will be seen that a large number of steel and iron sailing ships are built in the latter country. The figures are exclusive of naval vessels:

Table No. 7.—Iron and Steel Ship Building.

	Sailing.		Steam.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.
United States.						
1888	4	747	39	35,972	43	36,719
1889	1	33	47	53,480	48	53,513
1890	..	.....	63	80,378	63	80,373
1891	..	.....	76	105,618	76	105,618
Great Britain.						
1888	81	80,959	458	757,081	539	838,040
1889	95	125,568	595	1,083,793	690	1,209,361
1890	92	133,086	651	1,061,619	743	1,194,705
1891	181	252,463	641	878,353	822	1,130,816

The production of basic steel in all countries amounted in 1891 to 2,603,083 gross tons, of which 2,232,639 tons were made by the Bessemer and 370,444 tons by the open-hearth process. The total production since the invention of the basic process down to the close of 1890, is reported at 13,448,000 tons. The following table shows the production by countries:

Table No. 8.—Basic Steel Production.

Countries.	1887.	1888.	1889.	1890.
England	364,520	408,594	493,919	503,400
Ger., Lux., Aus.	1,102,496	1,276,070	1,481,642	1,695,472
France	176,500	222,333	222,392	240,638
Bel., Rus., U. S.	60,959	46,237	76,599	163,573
Total	1,704,481	1,953,234	2,274,552	2,603,083

Finally, we give in table No. 9 the leading particulars of the world's production of iron ore, pig iron and steel, although they are not all for the same year, and there may therefore be some discrepancies in the comparison:

Table No. 9.—Iron and Steel Production of the World.

	Iron Ore.	Pig Iron.	Steel.
United States	16,036,043(a)	8,279,870	3,904,240
Great Britain	13,780,767(a)	7,228,496	B.. 1,642,005 O.H.. 1,514,538
Germ. and Lux.	10,657,000	4,524,816	2,352,074
France	.....	1,919,185	765,290
Aust.-Hung.,	(a)	925,308	499,600
Belgium	.....	688,056	243,729
Spain	(a) 5,788,743	243,366	63,011
Russia	(1889)	745,872	263,719
Sweden	(a) 941,241	456,102	(b) 451,118
Italy	(a) 220,702	14,346	107,676
Canada	(a) 68,313	19,439	(c) 24,886

(a) These figures are for 1890.
(b) Iron and steel.
(c) Production for 1889.

The several parts of the first 13-in. gun have been delivered to the naval gun shops by the Bethlehem Iron Co.

THE OPENING OF THE CHICAGO & SOUTH SIDE ELEVATED RAILWAY.

The first train on the Chicago & South Side Rapid Transit Co.'s line, popularly known as the "Alley L" road, was run from the Congress St. Station to 40th St. on May 27. Invitations were sent out to the Mayor and City Council and 350 representative citizens.

Engine No. 15 drew a six-car train over the four miles now open in 11 minutes, and then returned, making stops at various stations. On the following day an excursion over the road was tendered to several hundred ladies. The road will be formally opened for traffic on June 6. Trains will run on 2½ minutes headway between 6 and 9 a. m. and 4 and 8 p. m.; on 5 minutes' headway from 9 a. m. to 4 p. m.; on 6 minutes' headway from 8 p. m. to midnight, and on 20 minutes' headway from midnight to 5 a. m.

Full descriptions of the road and rolling stock have been published in our issues of Jan. 16 and Feb. 20, 1892. Work is in progress on the extension of the structure in both directions, to termini on the north at Van Buren St., and on the south at 63d St. and Jackson Park. Mr. C. L. Strobel, of the Keystone Bridge Co., states that about 10,000 tons of material have already been furnished. Frank J. McCain & Bro., of Chicago, are the contractors for the erection of the structure. About 20 foundations a day are being put in, and before the end of the year passengers will be carried as far south as 47th St. Yards and repair shops for the road are to be erected between 61st and 63d Sts. The present equipment of rolling stock includes 20 Vauclain compound locomotives, burning anthracite, and 60 cars very similar to those on the Manhattan Elevated Ry. The financial prospects of the company are considered so good that its stock sold at par before the rolling stock was received.

The opening of this line marks a new era in the development of rapid transit in Chicago. The need of better transit facilities is becoming more and more evident, as overcrowded cars in the rush hours are becoming as common on the cable and steam suburban lines as they are in New York City.

DISPOSAL OF HOUSE REFUSE AT LIVERPOOL, ENGLAND.

A paper on the removal of house refuse or garbage and the disposal of the material was read by Mr. H. P. Boulnois, City Engineer, at a meeting of the Liverpool Engineering Society on April 20, as noted in our issue of May 12. The following is an abstract of the paper:

In former years the house refuse was of some considerable value for agricultural and other purposes, but of late years the character of this material has considerably changed. In the first place, improved means of combustion and the introduction of gas stoves have lessened the amount of ashes, and the introduction of tinned meats and vegetables has not only lessened the amount of vegetable and organic refuse, but has added a large quantity of tin cases to the already unwieldy bulk of this material; and the tins found in the refuse have so far been found of very little, if any, commercial value. There are three methods by which the collection of house refuse may be undertaken by a local authority: First, the house-to-house call system; second, the bell cart system; third, public dustbins, placed in suitable localities. Experience alone can teach which of these is the best to adopt in any district, and it is usually found that some modification of all three is necessary. With regard to the house-to-house call system, which is the best and most sanitary method of collection, the question of how the material is to be temporarily stored pending the visit of the scavenger is of some importance. The large fixed open ashpit is not a good sanitary arrangement; it might be necessary for large establishments, such as hotels, schools, hospitals, and the like, but for private establishments movable covered receptacles, constructed of iron or other impervious material, are far better on sanitary grounds.

He was of the opinion that improvements might be effected in the carts which removed house refuse; at all events, they might be covered, so as to avoid paper and dust being blown about in high winds. The character of house refuse is changing every year, and the demand for it has become less and less for either agricultural or brickmaking purposes. Consequently, it has become a question of how to dispose of this heterogeneous material in the most economical, expeditious and sanitary manner. In some cities, notably New York and Liverpool, for some years past the bulk of the house and trade refuse has been barged away to sea, and there sunk in deep water.

In Liverpool there are two special steamers belonging to the Corporation, which carry, when fully loaded, 330 tons and 400 tons, respectively. Each vessel has a large central well or hopper divided into ten compartments, with vertical or slightly undercut sides. Every compartment is provided with a pair of doors, each about 10 ft. by 4 ft., hinged to the keel and bilges, which can be raised and lowered by chains through gearing worked by a small engine provided for this purpose. The vessel employed at the north end of the town was originally intended to be loaded direct from the garbage carts, but as it was found impossible to obtain a quay berth from the Dock Board, it became necessary to load the vessel from canal barges, which was originally done at night by 35 men shoveling the material on board. This was an exceedingly slow and costly process. Consequently, for some time past special iron canal barges have been employed, each carrying about 50 tons of material and fitted with large light steel and steel-framed wooden boxes, each box holding, when full, about two tons of refuse. These canal barges are loaded with the refuse at certain places on the Leeds and Liverpool canal from the carts, which dump over projecting cantilever platforms directly into the boxes in the barge. When the barge is loaded it is taken down the canal to the Collingwood Dock, and brought alongside the steam hopper barge, the hopper of which is 60 ft. long by 16 ft. wide. A large boom or derrick, 65 ft. long, is fixed to the mast, and is worked from a double-barreled deck winch, one barrel being used for lifting and lowering the boxes, and the other for slewing the boom outboard and inboard as required, by means of a steel rope and outrigged arms. This arrangement is worked by one winchman, and four laborers, who hook on and dump the boxes, and on several occasions no less than 55 tons have been discharged from the canal barges into the hopper barge in 17 minutes.

One vessel is loaded in this way. The other vessel is loaded direct from the carts at one of the southern docks. Both vessels when loaded proceed to the deposit ground, at a distance of about 24 miles from the landing stage, where the refuse is discharged by lowering the doors and allowing the material to pass through after which the doors are again raised and the vessel returns to the river, the total trip occupying about seven hours. She then awaits the opening of the dock gates, and returns to her berth. During 1891 there were 145,032 tons of refuse deposited in this manner, costing (including loading into the barge) approximately 37 cts. per ton.

There is no doubt that for seaport towns this method has considerable advantages; but there is always some difficulty experienced with the lighter descriptions of material which float upon the water, and are said eventually to be cast up on the coast. It is also stated that fishing with trawling-nets is much interfered with, owing to the tins that are cast up interfering with the nets. There is a further difficulty about the weather sometimes preventing the vessels proceeding to sea. The difficulties thus experienced in attempting to dispose of the house and trade refuse in an economical and sanitary manner have led to attempts being made to destroy it by fire. Such attempts were made as early as the year 1870; and in the city of Liverpool, his predecessor, Mr. Clement Dunscombe, erected a crematory at Sandhills, which is still in operation, but this was on a very small scale, and is only used for the lightest trade refuse, such as baskets, straw, paper, etc.

Mr. Boulnois gave a description of the best known destructors, and then described a destructor which he had recently erected, and to which an important and valuable improvement had been made by his assistant, Mr. Brodie. From the experience gained of the working of this destructor he was of opinion that it was a success, and this opinion was shared by the committee which had charge of the disposal of the refuse, for they had desired him to report upon the cost of erecting 12 more cells adjacent to the 12 already erected.

From a table that he had prepared with regard to the cost of the erection of refuse destructors he found that the average height of the chimney shaft was 158 ft., and the cost of construction per cell was $4,010. The cost of destruction might be taken to vary from 12 to 54 cts. per ton. The present cost of destruction in the Liverpool destructor is about 30 cts. per ton, exclusive of interest upon the capital expended in its construction, but he believed that this cost would be eventually reduced when further improvements, suggested by the experience of working, had been introduced.

TESTS OF PAVING BRICK AT BOSTON.

Boston now has about a third of a mile of brick pavements, laid on four streets. One of these streets is a private way and the brick was laid in 1888 at private expense. On the other streets brick was laid in 1891. The Street Department of Boston seems to be making a careful study of brick as a paving material, and its report for 1891 contains the results of some tests, which are given below.

The tests for abrasion were made with a foundry "rattler"—that is, by placing the bricks in a revolving cylinder with one or two hundred pounds of "foundry shot," or nuggets broken from iron castings. The results of these tests are given below for 18 samples, and at the right is given the absorptive power of some of the samples in per cents. of the volume of the dry brick. The figures are as follows, the second, third and fourth columns being for first, second and third half hours, respectively:

Resistance of Paving Brick, Stone and Asphalt to Abrasion and Impact, as Shown by Mechanical Tests with a Foundry "Rattler;" also Absorptive Power of the Material.

	Loss p. c. of original weight.			Absorption, p. c. vol. of dry brick.
	Each half hour.		In 1½ h.	
	Granite and Asphalt.			
1	0.88	0.46	0.37	1.71	0.8
2	3.63	2.57	2.42	8.62	
	Paving Brick.			
3	1.43	0.96	0.48	2.87	
4	2.83	1.15	0.93	4.97	
5	1.51	0.71	0.55	2.77	2.2
6	0.84	0.30	0.30	1.44	
7	0.68	0.49	0.37	1.54	1.5
8	0.62	0.49	0.37	1.48	2.0
9	0.62	0.56	0.49	1.67	1.5
10	2.81	1.76	1.22	5.79	3.0
11	1.98	1.86	1.68	5.52	6.0
12	1.03	0.54	0.36	1.93	
13	0.90	0.41	0.25	1.56	6.0
14	4.32	3.66	4.24	12.22	23.3
15	1.60	0.97	0.62	3.19	10.0
16	2.19	1.83	1.60	5.62	14.0
17	1.72	1.00	0.55	3.27	
18	1.66	0.90	0.67	3.23	

It will be seen from the above table that the range of loss by abrasion was from 1.44 to 12.22 per cent., and that the absorption ranged from 1.5 to 23.3 per cent., which shows that great care must be exercised in selecting brick for paving.

Samples 7 and 8 showed absorptive powers of 0.17 and 0.19 per cent. of the weights of the dry brick. Samples 7, 8 and 9 were tested for transverse strength at the Watertown Arsenal, and showed moduli of rupture of 1,925, 2,072 and 1,700 lbs. per sq. in. respectively.

ELECTRIC LIGHT IN LIGHTHOUSES.

Electric lights in lighthouses, says Prof. Tyndall, are useless in a fog and a nuisance to mariners on clear nights. In the latter case, they dazzle the eye and mislead as to distance. In a fog the 7,000,000 c. p. electric light at St. Catharine's Point could not be seen by the North-German Lloyd steamer "Elder," on the night of Feb. 2, at a distance of 3½ miles, and Prof. Tyndall thinks it probable that it would not have been seen in the prevailing dense fog at a distance one-quarter of a mile. This most powerful light in the world was, under the circumstances, no better than the 730-c. p. oil lamp it superseded.

To inform himself of the conditions, Prof. Tyndall sent a trained observer to the Isle of Wight with the following results: In a thin fog, at a point three-quarters of a mile away, the light gave a dull glow in the fog, which would have been mistaken for moonlight had it not been for the intermittent flashes of the light. As the fog increased in density the light disappeared entirely, and at 500 yds. from the lantern neither direct beam or glow were to be seen. There was literally no indication of the proximity of a powerful light.

Prof. Tyndall says his own hopes and enthusiasm regarding the electric light have been sobered down by experience. He now strongly indorses the group flashlight of John Wigham, of Dublin. In this light, as originally designed, five different processes were employed. The smallest one, for fair weather use, has 28 fish-tail gas jets compactly grouped, and this was increased as occasion demanded, by groups of 20 jets, to 48, 68, 88, and finally to a larger fog burner of 108 jets. In the case of a revolving light the larger the burner the wider is the beam sent seaward, and the longer the time occupied by the beam in sweeping past the mariner. So Mr. Wigham takes advantage of this 20 seconds of time by flashing his light, by suddenly quenching and automatically lighting the gas again, a certain number of times. Mr. Wigham also removes the top and bottom prisms of the French apparatus, and superposes the central belts of prisms, so as to build up a bi-form, tri-form or quadri-form tower. At the focus of each tier he places his powerful burner, and thus triples or quadruples his light. This light is singularly satisfactory to mariners.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

PORTLAND & RUMFORD FALLS.—It is expected to have tracklaying on the extension from Gilbertsville to Rumford Falls, Me., 14 2-5 miles, completed by June 6.

PLYMOUTH & MIDDLEBORO.—Tracklaying will begin at once on this railway from Plymouth to Middleboro, Mass., 16 miles.

CONCORD & MONTREAL.—The lease of the New Boston R. R. has been authorized by the directors of this company and it is probable that construction may begin soon. The line as surveyed will run from Goffstown to New Boston, N. H., 5¼ miles.

ADIRONDACK & ST. LAWRENCE.—W. Seward Webb, Pres., is reported as saying that this road from Poland to Malone, N. Y., would be completed and in operation by July 1. About 106 miles of track have already been laid, and a large force is now at work.

PENNSYLVANIA.—Contractors are now figuring on the Roxborough branch, from Germantown to Plymouth, Pa., about 10 miles. It is expected to have the line completed by Jan. 1.—Work has been begun on the short branch from Hart's Lane to Bustleton, Pa.

WESTERN MARYLAND.—About 12.2 miles of track have been laid on the Potomac Valley R. R., from Williamsport to Cherry Run, W. Va., 14.35 miles, and it is expected to have all the track laid by June 15. The bridge across the Potomac River has been completed. It consists of five 140-ft. steel and iron combination spans, with masonry foundations.—The contract to build the line from Porter's Station to York, Pa., 15 miles, has been let to Wright & Langhorn, Richmond, Va. Work will begin at once.

NEW YORK, NEW HAVEN & HARTFORD.—Surveys have recently been completed for a branch from Woodmont, Conn., to a point about three miles south of Derby, Conn., 5½ miles long. The line, it is stated, will be built at once, and will be double tracked. The work will be quite light; maximum grade 33 ft. per mile.

McKEESPORT & BELLE VERNON.—Surveys are in progress for a line connecting this railway at Fayette City, Pa., with the Pittsburg, McKeesport & Youghiogheny R. R., at Layton, Pa., about 13 miles long.

CHICAGO & WEST MICHIGAN.—Ch. Engr. J. J. McVean informs us that this line from Traverse City to Petoskey, Mich., 80 miles, will be opened for traffic in June. About 70 miles of the track have been laid.

GOUVERNEUR & OSWEGATCHIE.—Moffett, Hodgkins & Clarke will soon sublet the contracts for building this branch of the New York Central & Hudson River R. R., from Gouverneur to Edwards, N. Y.

COLUMBUS, LIMA & MILWAUKEE.—A press dispatch from Lima, O., says: "The Columbus, Lima & Milwaukee R. R. deal has finally been closed, and the work of completing the road will be commenced at one. The syndicate, with F. G. Freeman, of New York, at its head, has secured the road. A number of Defiance people are interested with Mr. Freeman, and the road will be built between Lima and Defiance, O., within 90 days. The roadbed is ready for the ties and rails between these points, with the exception of the bridge at Defiance, which remains to be finished."

COLUMBUS, HOCKING VALLEY & TOLEDO.—This company will probably soon make a survey for an extension from Gallipolis, O., to North Kenova, O.

PHILADELPHIA & READING.—Work will be begun at once on the Philadelphia & Northern R. R., from Wistar Station, on the Philadelphia & Germantown branch, to Glenside Station, on the North Pennsylvania division.

BUFFALO, ROCHESTER & PITTSBURG.—The surveys have been completed, and work is in progress on the 27-mile extension from DuBois to Clearfield, Pa. The line is to be completed by Nov. 1.

Projects and Surveys.

BANGOR & AROOSTOOK.—It is stated that work will begin this month on the section of this line from Brownville to Houlton, Me. It is expected to have a considerable portion of the line completed this session.

OSCEOLA LAKE & WEXFORD.—This company has been chartered to build a railway from Otga, Lake Co., Mich., to Hoxeville, Wexford Co., Mich. Among the incorporators are Wm. F. Chittenden and others, of Cadillac, Mich. The line is in the interest of the Chittenden Lumber Co.

LUDINGTON & BIG RAPIDS.—A local company is to be formed by Thos. McMaster and others of Ludington, Mich., to build a railway from Ludington to Big Rapids, Mich.

Southern.—Existing Roads.

PADUCAH, TENNESSEE & ALABAMA.—The surveys have been completed for the extension from Hollow Rock, Tenn., to a connection with the Tennessee Midland R. R. at Darden, Tenn., and contracts for construction will be let at once.

WEST VIRGINIA CENTRAL & PITTSBURG. The new survey for the Baltimore & Cumberland R. R., east of Hagerstown, Md., has reached a point near Hancock, Md. A preliminary survey was made last fall for the section from Cumberland to Hazerstown, Md., 82 miles, and a reconnoissance completed for the remainder of the line to Baltimore, Md. The survey is in charge of Ch. Engr., Jas. Parsons.

BRISTOL, ELIZABETHTOWN & NORTH CAROLINA.—Arrangements are being made to resume work on the partly graded section of this line from Bristol to Elizabethtown, Tenn. Ch. Engr., Geo. S. Bruce, Bristol, Tenn.

NORFOLK & WESTERN.—The contract for building the extension of the Cripple Creek branch from Ivanhoe to Sneedwell, Va., has been let to Rodgers & O'Brien, who have begun work.

Projects and Surveys.

GENEVA, FLORALA & PENSACOLA.—At a recent meeting of the stockholders of this company the following officers were elected: Pres., W. C. McLaughlin; V.-P., W. B. Gilmer; Secy., J. S. Collins, and Treas., J. D. Holloway. The road is projected to run from Geneva, Ala., to Pensacola, Fla., and surveys are now in progress. The route is through a good timber country, and the principal traffic will be timber and timber products. Ch. Engr., J. W. Persons, Montgomery, Ala.

Northwest.—Existing Roads.

WISCONSIN CENTRAL.—It is stated that the contract has been let for building a branch from Emerald, Wis., to a connection with the Chicago, St. Paul, Minneapolis & Omaha Ry., at Wildwood, Wis., about 10 miles.

CHICAGO, BURLINGTON & QUINCY.—The contract for grading the extension from Old Monroe, Mo., southeast, via the Bellefontaine Bluffs to St. Louis, Mo., about 2 miles, has been let to R. M. Quigley & Co., of St. Louis, Mo., who have a large force of men at work. There will be a large bridge across the Missouri River at Bellefontaine Bluffs.

DAKOTA, WYOMING & MISSOURI RIVER.—A press dispatch says: "Jas. M. Woods, Jas. Halley, John R. Brennan, V. T. McGillicuddy and H. S. Hall, the bond committee of the Rapid City, S. Dak., Board of Trade, are in Chicago for the purpose of meeting Pres. W. T. Coad, of the Dakota, Wyoming & Missouri River Ry. Co., and are arranging for the negotiation of $50,000 of the aid bonds to be used in the construction of the road. This sum if part of the $100,000 granted by the city in aid of the enterprise. The grading west to Mystic, S. Dak., on the line of the Burlington & Missouri River R. R. is about three-fourths completed, and upon the company's furnishing guarantees that the road will be finished, the sum realized upon the bonds will be used in putting the roadbed in condition for ironing. A letter has been received from Mr. Coad, stating that he had completed all arrangements for bonding 250 miles of road, the money to be paid at the rate of $20,000 per mile as fast as the road is ironed. He does not state the destination of the road, but as the project originally contemplated the building of a line from Rapid City westward to the Wyoming coal fields and eastward to Pierre, S. Dak., is surmised that these are to be the terminal points."

IOWA CENTRAL.—It is stated that efforts are being made by the people who have surveyed the line for a railway from Springfield, Mo., to Centerville, Ia., presumably the Springfield, Sedalia, Marshall & Northern and allied lines, to induce this company to take up the enterprise.

CANADIAN PACIFIC.—The following extract from the annual report for the year 1891 shows the construction work done last year and that contemplated for the present year: "During the present year the Souris branch was extended 82.3 miles to Oxbow, and the Glenboro section of the Souris branch was extended to Nesbitt, six miles. The completion of the main line of the Souris branch to the coal fields of southern Assiniboia, 40 miles, on which the grading is well advanced; the completion of a connection between the southwestern branch at Deloraine and the Souris branch at Napinka, 17.8 miles; a section of 18.2 miles connecting the Glenboro branch at Nesbitt with the Souris branch at Souris, and a branch of 30 miles westward from the South branch at Menteith to the well settled Pipestone district, are contemplated for the present year. Toward the construction of these line the province of Manitoba will give assistance to the extent of $1,750 per mile, and to all except the Pipestone branch a grant from the Dominion Government of 6,400 acres of land per mile attaches, and a similar grant is expected for the Pipestone branch. It is the intention of your directors to commence the grading of a line from the southern Assiniboia coal fields to a connection with the main line at Regina or Moose Jaw, and another line from a point near Fort McLeod toward the Crow's Nest pass. The first named line will open for settlement one of the best sections of the company's land grant and will, with the extension of the Minneapolis, St. Paul & Sault Ste. Marie Ry., now being made, afford a direct and necessary connection, under your company's control, between the West and Minneapolis and St. Paul. The other line is intended to protect the company's interest in southern British Columbia, including the Kootenay district, which is now assuming great importance, owing to its remarkable mineral developments. The Calgary & Edmonton Ry. has been completed and is in operation from Calgary to Edmonton, a distance of 192 miles. On the portion of the line south of Calgary the rails have been laid to High River, a distance of about 40 miles, and the grading has been completed to a point near Fort McLeod, 110 miles from Calgary."

Projects and Surveys.

CHICAGO, PEORIA & NORTHWESTERN.—Chartered in Illinois by Jas. R. Lane, of Chicago, and others to build a railway from Chicago to Peoria, Ill.

BRAINARD & NORTHERN MINNESOTA.—Gen. Man. Ray W. Jones, Minneapolis, Minn., writes us that the surveys for this road, noted in our issue of May 19, were commenced on May 1, and that 16 miles of the line have been surveyed. The road will be 74 miles long, and will run from Brainard, Minn., where it will cross the Mississippi River on a combination wood and iron bridge, in a northwest direction through Townships 134 and 135, Range 28, and Township 133 in Range 29. All of the right of way has been secured and about $100,000 in bonds have been issued by Crow Wing Co. in aid of the road. Pres., John S. Pillsbury and Ch. Engr., David Fornerl; both of Minneapolis, Minn.

WISCONSIN BEE LINE & WEST SUPERIOR.—A dispatch from Fond du Lac, Wis., says: "The Wisconsin Bee Line & West Superior R. R. Co., which proposes to build a line to Superior, and which has already absorbed the Weyerhauser Road, has executed a mortgage of $15,000,000 to the Central Trust Co., of New York, to secure funds for the construction of the road. The bonds are now being negotiated in New York. The proposed line will be about 700 miles in length."

Southwest.—Existing Roads.

EAST LOUISIANA.—The branch from Abita Springs, La., south to Lake Pontchartrain has been completed and will soon be opened for traffic.

LA PORTE, HOUSTON & NORTHERN.—This railway, previously noted as the La Porte & Harrisburg R. R., will run from La Porte to Harrisburg, Tex., 16½ miles. The preliminary survey of the line has been completed and location is in progress. J. F. Allen, of Lincoln, Neb., has the contract for building the line and will soon begin work.

HEARNE & BRAZOS VALLEY.—The citizens of Calvert, Tex., are trying to secure the extension of this road to that place.

Projects and Surveys.

SPRINGFIELD, YELLVILE & WHITE RIVER.—Work has been commenced on this railway in Marion Co., Ark. As surveyed the line will run from Buffalo City, near Yellville, Ark., and run northwest to George's Creek, Ark., about 20 miles. Ultimately the line will be extended to a connection with some of the existing lines of railway at the north, but the present object of the road is to give an outlet for the timber lands along its route. At Yellville it connects with navigation on the White River.

HOXIE & POCAHONTAS.—Wm. D. Gentry, 100 Washington St., Chicago, Ill., Pres., writes that this road is projected to run from Hoxie, Ark., north via Pocahontas, to the Missouri state line, a distance of 35 miles. The route was surveyed about three years ago, and about five miles have been graded, three miles partly graded, and the right of way cleared to Pocahontas. The route is through a level country affording light work. There will be a bridge over the Black River at Pocahontas, 2,400 ft. long. The right of way has been all secured and other local aid obtained. The principal business of the road will be in cotton, timber and general farm produce. Carroll C. Hughes, Hoxie, Ark., has the contract for building the line, and work is to be rapidly pushed, so as to complete the road by Oct. 1.

SHREVEPORT & TEXARKANA.—Caddo Parish, La., is advertising for proposals for the construction of a railway from Shreveport, La., to Texarkana, Ark., or to the terminus of the Texarkana & Ft. Smith R. R., a distance of about 50 miles. J. M. Foster, Pres., Police Jury, Shreveport, Caddo Parish, La.

MONET, BALD KNOB & MEMPHIS.—This company has been organized by local capitalists to build a railway from Monet, Mo., to Bald Knob, Ark., passing through lead and zinc fields of southern Missouri and northern Arkansas.

FORT WORTH & TRINITY VALLEY.—At a recent meeting of the stock holders of this company which was chartered in December, 1891, it was decided to begin the surveys and to construct the line at once. The company was chartered to build a railway from Ft. Worth, Tex., to the north line of the state in Clay Co., The officers of the company are Stephen S. Brown, St. Joseph, Mo., Pres.; Martin Casey, Fort Worth, V.-P.; Charles L. Frost, Fort Worth, Secy. and Treas.; Wm., L. Candler, Boston, Mass., Asst. Treas.

HOUSTON BELT.—The contracts for the belt line railway at Houston, Tex., will be let within the next 30 days, it is stated. The work will include an iron drawbridge and about 2,000 ft. of double track, iron trestle. Pres., R. H. Harrison, Houston, Tex.

Rocky Mt. and Pacific.—Existing Roads.

UNION PACIFIC.—It is stated that new surveys will be made soon for the Portland & Puget Sound R. R., from Portland, Ore., to Seattle, Wash., about 185 miles. The line was located in 1890 and a considerable amount of grading was done, but upon the change of management work was suspended, and nothing has been done since. The line was being built by this company in conjunction with the Great Northern Co., and the new surveys are being made by the latter company. It is stated that the old line, which had some rather heavy grades, 70 ft. and 80 ft. to the mile, will be changed so as to bring the maximum grade down to 1%.

SOUTHERN PACIFIC.—Work on the line from Collis to Fresno, Cal., 14 miles, is progressing rapidly, and tracklaying will begin this week.—Surveys are in progress for a branch from Copperopolis, Cal., via Angels and Murphy's to the Calaveras big trees.

Projects and Surveys.

BUCKSPORT & ELK RIVER.—F. E. Herrick, Ch. Engr., 1237 I St., Eureka., Nev., writes us that this railway mentioned in our issue of April 28 will be four miles long and will be used for logging purposes only. The line has been surveyed and construction will begin about June 10.

HELENA & CASTLE.—The citizens' committee appointed to secure the construction of a railway from Helena to Castle, Mont., about 100 miles, has signed a contract with a syndicate of capitalists for its immediate construction. The road will pass through a mountainous country, and the work will be heavy, including a 5,700-ft. tunnel. Work is to begin at once, and 40 miles of the line completed this year.

FLORENCE, CRIPPLE CREEK & STATE LINE.—The surveys for this line from Florence, Colo., to the Cripple Creek mines are about two-thirds completed. Nearly all of the right of way has been secured and it is expected that within 30 days matters will be ready for receiving bids for the construction of the line. Gen. Man., J. C. McCandless, Florence, Colo.

SAN FRANCISCO & SALT LAKE.—A press dispatch from San Francisco, Cal., dated May 27, says: "The articles of incorporation of the San Francisco & Salt Salt Lake Co., which has been mentioned as the first competing railway extending out of California, were filed here to-day by Alvinza Hayward, Daniel Meyer, William Babcock, E. L. Steele and E. F. Praston, as Directors. The capital stock is $2,000,000. The road is to be completed within three years. There are to be other other corporations, one in Nevada, which will secure a Navada charter, and one in Utah, reaching to Salt Lake.

HILLSIDE MINERAL.—A number of Eastern capitalists, who have purchased the Hillside group of mines in Yavapai Co., Ariz., will, it is stated, build a railway 20 miles long, connecting them with the Santa Fe, Prescott & Phoenix R. R. H. W. Warren, of Rochester, N. Y., is interested.

YAKIMA & SUNNYSIDE.—This company has been chartered in Washington to build a railway from North Yakima to Prosser, Wash., along the Sunnyside country. Among the incorporators are Geo. B. Eaton, of Tacoma, Wash., Walter N. Granger, of North Yakima, Wash., and Wm. H. Hall, of San Francisco, Cal.

Foreign.

MEXICAN SOUTHERN.—A press dispatch from the City of Mexico says: "The work of construction on the Mexican Southern Ry. from Pueblo to Oajaca, capital of the state of the same name, is going forward rapidly. The line will be completed in September, when the event will be celebrated with public rejoicings in Oajaca. President Diaz and the Cabinet will attend the celebration. The part of the line that is already in operation is showing earnings far in excess of the estimate by the engineers at the outset."

COMPANIA CARBONIFERA.—A press dispatch from Eagle Pass, Tex., says: "The Compania Carbonifera, the owner of the Fuente coal mines and which holds

a valuable concession for a railway to Monterey, from this place has sent out the chief engineer and the locating engineer with a party of men to locate the line from the mines to Lampassas and thence to Monterey. Recent developments have demonstrated that there are more than 3,000,000 tons of coal in sight, and it is believed the road will be speedily built."

MICHOACAN SOUTHWESTERN.—The following description of this proposed Mexican railway is given in a New York city paper: "This line will start from Coapa, 250 miles distant from the Mexican National Ry., to a point on the Pacific Coast, perhaps the bar at Zacatula. H. E. Dennie, the concessionary, has finished the preliminary studies of the line and has staked 30 kilos. of the first division, the plans being ready to be presented to the Secretary of Public Works. The length of this line will be about 300 kilos., 30 of which will have to be finished during the first year to begin from June 15, next, and 30 kilos. every subsequent two years. The grades are comparatively light, the maximum being 2.9% for a short distance only. This road will run through some of the most productive timber sections of the republic. Saw mills will be established along the route. The work has already been begun at Coapa Station. The timber in general is pine, pruche, and encina. The line will also run through the fertile lands of Michoacan, from which cattle will be shipped to the City of Mexico. The engineering work is at present under the direction of Mr. H. E. Matton."

MEXICAN NORTHERN PACIFIC.—This company has awarded construction contracts to Huss, Townsend & Co., Rookery Building, Chicago, Ill. The proposed road is to extend from Deming, N. Mex., to Guerrero, Chihuahua, Topolobampo and Guaymas, Mex. The company is backed by Sir Edward Watkin, Sir James Kitson, and other English railway men.

AFRICA.—The Trans-African Ry., which starts from St. Paul de Loando, on the East Coast, has been opened for traffic as far as Cassange, a distance of 300 miles.

ELECTRIC RAILWAYS.

MANCHESTER, N. H.—The Manchester Street Ry. Co. has decided to build an electric road to Lake Massabesic. Secy., Chas. H. Bartlett.

WORCESTER, MASS.—The Worcester Consolidated Street Ry. Co. proposes to adopt electric traction on some of its lines.

LOWELL, MASS.—The Lowell & Suburban Street Ry. Co. will extend its electric line to North Billerica.

LEWISTON, N. Y.—The Lewiston & Youngstown Ry. Co. has elected officers: Pres., W. S. Philpott; Secy., Thos. McDowell.

NEWARK, N. J.—The Newark Plank Road Co. has been authorized by the Street and Water Commission to build a double track electric road.

KINGSTON, PA.—A survey has been made for an electric road to Carlisle. J. H. Bosler, of Carlisle, is interested.

PHILADELPHIA, PA.—The ordinance permitting the Traction Co. to adopt the overhead trolley wire electric system has been vetoed by the Mayor.

ALEXANDRIA, VA.—The contract for the construction and equipment of the line to Mount Vernon has been awarded to H. Ward Leonard & Co., of New York, at about $190,000.

MACON, GA.—The Macon Consolidated Street Ry. Co. has been organized by the purchasers of the two roads mentioned last week.

PORT HURON, MICH.—The Port Huron Electric Ry. Co. will build an extension, two miles long, and will purchase 350 tons of 45-lb. T-rails, 6 cars, and 2 miles of copper wire. The estimated cost of the extension is $60,000. Pres., S. L. Ballentine; Secy., A. Dixon.

TORONTO, ONT.—The Toronto Railway Co. is making arrangements to introduce the overhead trolley system, the City Council having finally given its consent. The company will replace the present rails with grooved rails weighing 70 lbs. per yd., and the city will at the same time lay a permanent pavement on concrete foundation on the principal streets. It is hoped to have the system in operation on the principal lines by September. Mr. C. H. Rust is City Engineer.

NEW COMPANIES.—Harrisburg & Mechanicsburg Electric Ry. Co., Harrisburg, Pa.; $75,000, with $7,500 paid in; Pres., E. Z. Wallower, Harrisburg. South Side Ry. Co., Denver, Colo.; $150,000; John C. Montgomery, F. B. Gibson and C. P. Butler.

ELEVATED RAILWAYS.

NEWARK, N. J.—The Newark & New York Elevated Ry. Co. has been organized by S. W. Davis, of Brooklyn, N. Y.; W. H. Clough, of New York, N. Y., and J. R. Appleby, of Jersey City, N. J.; capital stock, $100,000.

BALTIMORE, MD.—The Lake Roland Elevated Ry. Co. will award contracts for construction shortly. Among the directors are Samuel M. Jarvis and R. R. Conklin, of Kansas City, Mo.

CHICAGO, ILL.—The Chicago & South Side Rapid Transit R. R. Co. proposes to extend its line to Englewood. Large quantities of material are being received for the line to the exposition grounds. Coke fuel is being used. Work has been resumed on the Lake Street Elevated Ry., and material is beng shipped by the Pencroyd Iron Works.

HORSE AND MOTOR RAILWAYS.

WESTCHESTER, N. Y.—The West Side Surface Ry. Co. has applied for permission to lay tracks.

LONG BRANCH, N. J.—A street railway is proposed by R. Percy Dobbins.

DENVER, COLO.—The Denver, Lakewood & Golden Ry. Co. is experimenting with a motor car of the Patton Motor Co., in which electricity is generated by a gas engine on the car.

NEW COMPANIES.—Flushing & Long Island City Ry. Co., Flushing, N. Y.; $100,000; S. S. Jones and F. S. Smith, of Long Island City, N. Y., John Miller, of Flushing. Penn St. Ry. Co., Allegheny, Pa.; $50,000; Pres., J. J. Donnell. People's Park Ry. Co., Paterson, N. J.; $15,000; A. A. Van Voorhies, A. H. Post and J. Wadsworth.

HIGHWAYS.

MASSACHUSETTS.—Proposals will be received June 4 by the Selectmen of Stoneham and Melrose, for the construction of a county road. Engineer, W. C. Stevens, of Melrose.

NEW JERSEY.—The Essex Public Road Board, at Newark, will receive bids until June 6 for grading and telford paving on the Morris and Elizabeth turnpike. J. D. Hagan, Jr., Clerk. The Ridgewood Township Committee, at Passaic, has awarded contracts to Colfax & Steele, and the Ridgewood Stone Crushing Co. for macadamizing three miles and one mile, respectively. At the special election in Rutherford, on May 31, the vote was in favor of bonding the town for $75,000, $50,000 of which is for macadamizing the streets and $25,000 to start a sewer system.

OHIO.—The Hamilton Co., Commissioners have been petitioned for a new road. Herman Blair, of Cincinnati, is interested.

BRIDGES, TUNNELS AND CANALS.

LOWELL, MASS.—A special committee in regard to E. Merrimac state bridge reports it to be in bad condition, and recommends the construction of a new bridge.

CASTANEA, PA.—The County Commissioners have decided to build a new iron bridge across the Bald Eagle Creek at this place.

NORRISTOWN, PA.—The County Commissioners will build three new bridges and will advertise for proposals for both iron and arch structures. One of the new bridges is to be over the Perkiomen River, one over the Swamp Creek near Sumneytown, and the other will be constructed in Lower Salford township.

DAHLONEGA, GA.—Sealed proposals will be received until June 18 for the erection of a bridge at or near Leather's Ford. For particulars address B. R. Meaders.

MERIDIAN, MISS.—Sealed proposals will be received until June 6 for building a bridge across Roger's Creek. Address B. V. White, Clerk to Board of Supervisors.

KINGSTON, TENN, A $14,000 bridge will be built across the Emery River at Harriman, by Roane Co.

WATER-WORKS.

New England.

SOUTH BERWICK, ME.—We are informed that J. M. & W. A. Burleigh will soon ask bids for works, including pump, boiler, reservoir, one mile of 6, two of 4, and some 3-in. cast iron pipe.

CAPE ELIZABETH, ME.—The town has granted a franchise to the Standish Water & Construction Co., permitting the latter to supply water to eight villages within its limits. There will be not less than 34,000 ft. of 8, 20,000 ft. of 6, and 12,000 ft. of smaller pipe, and 50 hydrants. The supply will be obtained by connecting with the mains of the Portland Water Co., and a 600,000-gallon stand-pipe will be built. The town pays $50 each per year for 50 hydrants for a term of 20 years, after which the hydrants become the property of the town, and water is furnished free for fire protection. The town may provide and set at its own expense, hydrants in addition to the 50, to which water will be furnished without charge. The works must be in operation by Dec. 1, 1892.

BOSCAWEN AND PENACOOK, N. H.—These villages expect to have a water supply by fall. Wood pipe will be used. Water will be brought from Walker Pond, in Boscawen and Webster, through about 7½ miles of 12-in. pipe.

HANOVER, N. H.—The precinct is considering the building of works. A company put in a small plant in 1820.

ATTLEBORO, MASS.—The Committee on Water Supply has reported in favor of a new supply from a well near Orr's Pond, at an estimated cost of $53,077. The plan includes a well, pumping station, suction pipe, 5,720 ft. of 16 and 12,150 ft. of 14-in. pipe.

BRADFORD, MASS.—It is reported that S. W. Hopkinson and C. M. Hilton have been appointed to ascertain the cost of town works. A company furnishes the present supply.

Middle.

FAYETTEVILLE, N. Y.—It is reported that the village will issue $29,000 of bonds for the proposed works.

ROUSE'S POINT, N. Y.—The sum of $14,000 will be expended for improvements.

ROCHESTER, N. Y.—Bids will be received until June 6 by the Executive Board for about 900 tons of 16 to 44-in. cast iron pipe, and 50,000 lbs. specials. Thos. J. Neville, Clk.

WALDEN, N. Y.—Bids are wanted by the Water Commissioners until June 6 for excavated, driven or drilled wells to furnish a daily supply of 300,000 gallons, and a pump and fittings to lift the water 200 ft. above the railway at the depot. E. A. Nichols, Clk.

WHITESTONE, N. Y.—The Water Commissioners have decided to issue $50,000 of 4½% bonds for works. Authority to do this is conferred by a new charter.

ORANGE, N. J.—Bids will be received until June 6 at the office of the City Clerk for furnishing 4,000 ft. of mains and doing such trenching as may be required during the season. Supt., Thos. Dowd.

PERTH AMBOY, N. J.—Contracts for the distribution system of the new city works have been awarded to McRitchie & Nichol, Chicago, for $100,500, and for steam pumping plant to A. J. Loretz. Cy. Engr., J. C. Rossi.

HANOVER, PA.—The company has offered to sell its works to the borough for $60,000.

PENNSYLVANIA.—Charters have been granted since May 24, as follows: Belle Vernon Water Co., Belle Vernon, Pa.; J. C. Cunningham; $1,000. Suburban Water Co., Bryn Mawr; Treas., Wm. G. Thompson, Merion; $5,000. Carbondale Consumers' Water Co., Carbondale; Treas., J. D. Stocker, Jermyn; $30,000. Rush Brook Water Co., Jermyn; Treas., J. D. Stocker, Jermyn; $30,000. Marietta Water Co., Marietta; Treas., R. B. Kinsey, Reading; $1,000. Marietta Gravity Water Co., Marietta; Treas., Henry S. Rich, Marietta; $10,000. The latter company proposes to build a 15,000,000-gallon reservoir, it is reported.

WILMINGTON, DEL.—Bids are wanted for a 600,000-gallon "Church air lift pump" for a high service supply. Chf. Engr. Water Dept., J. A. Bond.

TANEYTOWN, MD.—It is reported that $5,000 will be expended for an increase in the water supply.

Southern.

WHEELING, W. VA.—It is reported that $30,000 of bonds will be sold for new mains.

TITUSVILLE, FLA.—An effort to obtain works is reported.

ELLISVILLE, MISS.—It is reported that the construction of works will soon be started.

HOPKINSVILLE, KY.—A 20-years franchise for water and electric lighting plants has been granted to J. P. Martin, Xenia, O. The works must be in operation within six months.

LEXINGTON, KY.—The purchase of the private works by the city is talked of.

North Central.

CLEVELAND, O.—The Council has ordered Director of Pub. Wks., R. Herrick, to advertise for a 15,000,000-gallon pumping engine.

BLOOMINGTON, IND.—The Council has voted against building works.

BATTLE CREEK, MICH.—It is reported that there will be an expenditure of $10,000 for an increase to the supply.

AUSTIN, ILL.—Pres. Bennett has vetoed the contract with the Cicero & Berwyn Water, Fuel and Light Co. for 250 hydrants at $30 each per year, to be located in the southern part of the town of Cicero. A proposition to pass the contract over the veto was defeated.

BELLVILLE, ILL.—A. M. Farnum and others have applied for a franchise. A company already supplies the city.

WASEKA, ILL.—It is reported that works will be built.

KAUKAUNA, WIS.—The Water-Works Committee has instructed Secy. R. Quayle to correspond with neighboring towns regarding works. A supply from artesian wells is proposed. A franchise will probably be granted.

PLATTEVILLE, WIS.—It is reported that works will be built.

Northwestern.

PRESTON, IA.—C. J. Storm, A. B. Grubb and R. M. Esaick have been appointed a Citizens' Water Committee to investigate and report on the cost of works.

O'NEILL, NEB.—In our issue of May 19 it was stated that a contract for works had been let to F. L. Burrell, of Fremont. The statement should have been that a contract for plans, etc., had been made.

WALLACE, NEB.—Bonds to the amount of $8,000 may be voted for works.

DEADWOOD, S. DAK.—Cy. Engr. Geo. H. Sharpe informs us that the city has voted $15,000 of bonds for the purchase of new water rights and the extension of mains.

Southwestern.

ST. LOUIS, MO.—The sum of $25,000 has been voted for laying mains by the Municipal Assembly.

AMARILLO, TEX.—L. H. Hallam informs us that there is talk of supplementing the windmills now used for pumping by some more reliable power, possibly for electric motors supplied from an electric lighting plant.

HENRIETTA, TEX.—Address J. N. Graves, Mgr., regarding a proposed $40,000 stock water company.

LITTLETON, COLO.—The Littleton Water-Works Co. has been incorporated; Directors: James Knight, R. W. Chandler and others; capital stock, $30,000. A franchise has been granted to Director Knight.

Pacific.

CHEHALIS, WASH.—The Chehalis Water Co. has been incorporated; capital stock, $50,000. A report states that Corkish & Hamlin have made arrangements with the Flume Co. and will build works at once, operating under a franchise formerly granted to Lawrence, Donahoe & Maynard. There will be 24 hydrants.

CORVALLIS, ORE.—Engrs. Adams & Gennell have estimated the cost of works at $27,864. The plan includes a pumping plant, 16 × 100-ft. stand-pipe, about four miles of pipe, and 20 hydrants.

LA GRANDE, ORE.—Cummings & Cook, Aberdeen, Wash., have received the contract for works at $42,880, construction to be finished in 90 days.

LOS GATOS, CAL.—A 25-years' franchise has been granted to Messrs. Bean, Beckwith and others. A company built works here in 1891.

OAKLAND, CAL.—Wm. B. Farwell is taking steps to condemn artesian land at Alvarado, preparatory to sinking wells and putting in works, including a pumping station and reservoir. It is proposed to supply the water developed to Oakland.

Canada.

YARMOUTH, N. S.—The Council has been authorized by a popular vote of 125 to 56, to expend $325,000 for the purchase and extension of the works of the Lake George Water Co., or the building of new works. The company offers to sell the town its works for $240,000.

ARTESIAN WELLS.

GUTHRIE, OK. T.—The Pabst Brewing Co. proposes, it is reported, to sink from five to ten 8-in. wells.

IRRIGATION.

GRAND JUNCTION, COLO.—The recently organized Mt. Lincoln Land & Water Co. proposes to raise water by means of two 61-in. turbine wheels, and four centrifugal pumps. Contracts have been let for six miles of ditch. Pres., C. W. Steele; Secy., Benton Canon; both of Grand Junction.

PERRIS, CAL.—The Directors of the Perris Irrigation District will receive bids until June 15 for the material and labor necessary in constructing No. 14 double riveted steel pipe as follows: 7,840 ft. of 15, 2,840 ft. of 14, 2,640 ft. of 13, 26,500 ft. of 12, 6,915 ft. of 11, 8,845 ft. of 10 and 6,700 ft. of 9-in. Also, No. 16 single riveted steel pipe as follows: 1,320 ft. of 8, 4,020 ft. of 7, 9,955 ft. of 6 and 1,000 ft. of 5-in. Separate bids will be received for excavating and refilling, and also for the pipe. Pres., W. F. Perry; Secy., H. A. Plimton.

NEW COMPANIES—Beaver River Irrigation Co., Milford, Utah; Pres., J. D. Pardee; Secy., Walter Brown, $300,000.

SEWERS.

ROCHESTER, N. H.—Bids are asked until June 14 for about 12 miles of 6 to 24-in. sewer pipe. J. F. Springfield, Cy. Engr.

LYNN, MASS.—The City Treasurer has been authorized to issue sewer bonds for $20,000.

WORCESTER, MASS.—The Council has ordered pipe sewers to cost about $12,000.

MERIDEN, CONN.—New bids were opened May 25 and contracts for sections 2, 3 and 4 were awarded to A. Brazos & Son, Middletown, at $79,376. Section 1 will be constructed by the city. We shall give the contract prices next week.

NEW YORK, N. Y.—Bids are asked until June 13 for three contracts. T. F. Gilroy, Comr. Pub. Wks.

TROY, N. Y.—Plans have been completed for an 18-in. pipe sewer in one street. Bids are asked until June 7 for a brick sewer in one street. E. O. Ross, Secy., Contracting Board.

BINGHAMTON, N. Y.—Bids are asked until June 6 for a brick sewer, 32×20 ins., and two salt glazed vitrified pipe sewers, 8 to 15 ins. in diameter. M. F. Garvey, Cy. Clk.

GENEVA, N. Y.—A system is being agitated; estimated cost, $80,000 to $100,000.

HERKIMER, N. Y.—Plans for a proposed system have been submitted by Mr. Baxter, Utica.

TROY, N. Y.—The City Engineer estimates the cost of a proposed brick sewer in Ferry St. at $23,000.

PATERSON, N. J.—Several 12 to 18-in. pipe sewers are to be constructed. J. C. Hendrie, Clk. Bd. Pub. Wks.

ROCHESTER, PA.—Bids are asked until June 6 for 680 ft. of pipe, and 725 ft. of brick sewer. J. P. Leaf, Engr.

DU BOIS, PA.—Councilmen Vosburg and Daly have been appointed a committee to negotiate with an engineer concerning surveys and plans for a system of sewerage.

YORK, PA.—The City Engineer has been authorized to employ a Sanitary Engineer to prepare plans for a system of sewerage.

ISHPEMING, MICH.—The Council has voted to construct a system of sewerage in two districts.

ROCK ISLAND, ILL.—The Sewer Committee has been authorized to ask for bids for a 36-in. tile sewer.

SULLIVAN, ILL.—The Council is corresponding with an engineer concerning estimates for a proposed sewer.

WAUKEGAN, ILL.—Bids will be opened by the City Council in June for the proposed sewer system.

MILWAUKEE, WIS.—The Board of Public Works has voted in favor of pipe sewers in 16 streets.

DEADWOOD, S. DAK.—We are informed by Geo. H. Sharpe, Cy. Engr., that the city has voted to issue bonds for $25,000 for sewers.

SIOUX FALLS, S. DAK.—The City Engineer has been instructed to prepare specifications for a complete system of sewerage. The estimated expense is $91,000.

BOONE, IA.—Plans for a system will be prepared by M. R. Laird, Des Moines.

OKLAHOMA CITY, OK.—The City Engineer has been instructed to prepare plans for sewers; estimated cost $10,000.

PUEBLO, COLO.—The Council has voted to construct a system of sewers in two districts.

PHOENIX ARIZ.—Surveys are being made for a system. The city seems much in favor of the project.

MONTESANO, WASH.—The Business Men's Club has passed resolutions in favor of bonding the city for $40,000 for sewers and other improvements.

PUYALLUP, WASH.—The city has accepted plans for a drainage system to cost $16,500. Bonds will be issued.

STREETS.

NEW YORK, N. Y.—Bids are asked until June 13 for 11 flagging contracts. T. F. Gilroy, Comr. Pub. Wks.

BROOKLYN, N. Y.—Bids are asked until June 6 for grading and paving one street with granite blocks and cobble stones. J. P. Adams, Comr. Cy. Wks.

BUFFALO, N. Y.—The lowest bids for two contracts were those of the Barber Asphalt Co., $150,574, and Buffalo Paving Co., $18,431.

JERSEY CITY, N. J.—Bids are asked until June 13 for improving Ogden Ave. E. A. Dugan, Chn., St. Com.

BLOOMFIELD, N. J.—The Road Committee has prepared plans for macadamizing to cost about $18,000.

RUTHERFORD, N. J.—At a special election, May 31, the citizens voted in favor of issuing bonds for $50,000 for macadamizing the streets, and $25,000 for constructing sewers.

RALEIGH, N. C.—The city is planning additional paving with Belgian blocks, to cost $1.50 per sq. yd., including curb.

WILMINGTON, N. C.—Bids are asked until June 6 for 3,000 tons Rondout, N. Y., macadam stone, crushed; 5,000 lin. ft. North River, N. Y., curb, 4×16 ins.; 200 lin. ft. Belgian bridge stone, 4×20 ins.; 50 set corners, 4×16 ins. A. G. Ricaud, Mayor.

CINCINNATI, O.—Bids are asked until June 15 for paving one street with brick; also, June 21, improving one street. A. P. Butterfield, Clk. Bd. of Admin.

FINDLAY, O.—The contract for paving Main St. has been awarded to I. N. Boren & Co., Canton-Malvern brick, $20,078.

PORTSMOUTH, O.—Bids are asked until July 6 for paving Second St. with vitrified brick or blocks, 11,055 sq. yds. R. A. Bryan is Cy. Engr.

YOUNGSTOWN, O.—Two streets are to be paved with brick, one at a cost of $25,000.

SALT LAKE CITY, UTAH.—The Council has voted to pave five streets with blocks and asphaltum.

ELECTRICAL.

SOUTH MANCHESTER, CONN.—A committee has been appointed to investigate the cost of electric lights. Address Town Clerk.

HEMPSTEAD, N. Y.—It is proposed to spend $2,500 per year for lights, and to ask for proposals from different companies.

JAMESTOWN, N. Y.—The plant is to be improved at a cost of $18,000.

ROCHESTER, N. Y.—The Council has decided to ask for bids for 500 lights, 1,000 lights, and also for lighting the whole city. A propositon to light the city with gas is published in another column.

LEBANON, PA.—The Council has passed an ordinance providing for a plant to cost $20,000.

SHARPSBURG, PA.—R. Miller is Chairman of the committee to investigate the cost of a municipal plant.

CLARKSVILLE, TENN.—M. W. Ingram is interested in a proposed plant.

HOPKINSVILLE, KY.—The contract for electric lights has been awarded to J. P. Martin, Xenia, O., who has a franchise for 20 years.

HOLLAND, MICH.—Proposals will be received until June 7 for a complete high tension arc light plant, including a boiler, 100-HP. high speed automatic engine, a 50-light dynamo, 40 lamps of 2,000 c. p., wires, poles, power station, etc. Geo. H. Sipp, Cy. Clk.

ELGIN, ILL.—Bids are asked until June 24 for one or two 35 or 50-light, low tension dynamos, for arc system, for extension of the city plant. J. Given, Chn., Com. on Lts.

OAKLAND, CAL.—The contract for public lighting has been awarded to the Oakland Gas, Light & Heat Co. at the following prices: Arc lamps from dusk to 1 o'clock, 40 cts. each per night; gas, after 1 a. m., moonlight schedule, 5 cts. per lamp; for public buildings, gas, $2 per 1,000 ft.

NEW COMPANIES.—The Nutley Electric Light, Heat & Power Co., Franklin, N. J.; $100,000; C. H. McIntire, Newark, E. Tuter and H. Edgar, Franklin. Belle Vernon Electric Light Co., Belle Vernon, Pa.; $1,000; Treas., J. C. Cunningham. Brownsville Electric Light Co., Brownsville, Pa.; $7,000; J. S. Elliott, W. E. Ledger, Bridgeport. Werline Electrical Specialty Co., York, Pa.; $25,000; H. E. Werline, W. G. Wolton. Hyslop Electric Supply Co., Lafayette, Ind.; $50,000; C. G. Longyear, W. B. Hyslop. Normal Electric Light & Power Co., Normal, Ill.; $25,000; J. W. Cook, A. S. Hatfield, F. B. Hillman.

CONTRACT PRICES.

PIPE AND CASTINGS.—Cleveland, O.—The following bids have been opened: J. B. Clow & Son, Chicago, pipe, $23 per ton; special castings under 16 ins., $50, and over 16 ins., $70 per ton. McNeal Pipe & Foundry Co., Burlington, N. J., pipe, $24.40; specials, $50. R. D. Wood & Co., Philadelphia, pipe, $24; specials, $49 and $67.50. Addyston Pipe & Steel Co., Cincinnati, pipe, $23.15; specials, $55 and $60. Lake Shore Foundry, pipe, $21.95; specials, $50. At a previous opening of bids the last named company was the lowest bidder, at $24.25 for pipe, and $50 and $70 for specials.

STREET WORK.—Philadelphia, Pa.—Contracts have been awarded as follows: Vulcanite Paving Co., asphalt paving, $2.60 and $2.70 per sq. yd.; Thos. Cunningham, Belgian blocks, $2.29 and $2.39 per sq. yd.; Donnelly & Scattergood, Belgian blocks, $2.39 per sq. yd.; T. P. Smart, Belgian blocks, $2.25 to $2.35 per sq. yd.; Mack Paving Co., Belgian blocks, $2.43; and vitrified brick, $1.85 to $2 per sq. yd.; B. M. Shanley, macadamizing, $1.40 per sq. yd.

Galesburg, Ill. Bids for paving four streets with brick range as follows: Grading, 15 to 20 cts. per cu. yd.; paving, $1.35 to $1.40 per sq. yd.; curbing, 52 to 59 cts. per lin. ft.

Latrobe, Pa.—The Council has received 13 bids for paving one street with brick, the prices varying from 31 to 65 cts. per cu. yd. for grading, 55 to 70 cts. per lin. ft. for curbing, $1.54½ to $2.34 per sq. yd. for vitrified brick, and $1.66 to $1.97 for re-pressed.

Wooster, O.—The lowest bid for paving one street with brick was that of Landers Bros. & Betson, $1.32 per sq. yd., and curbing, 33 cts. per lin. ft.

Pittsburg, Pa.—There were 147 bids submitted for street work, aggregating $300,000. The lowest for asphalt was $2.80 per sq. yd., and for stone blocks, $2.71. The prices last year were $3 to $3.34 for asphalt, and $3.15 to $3.50 for stone.

SEWER SUPPLIES.—Baltimore, Md.—Contracts have been awarded as follows: D. Donnelly & Son, brick, $7.50 per M. for hand made, $7.40 for machine made; Frederick Rice, brick, $7.98 for hand made; Y. O. Wilson Brick Co., brick, $6.85 for machine made; Port Deposit Granite Co., blocks, $1.50 to $2 per M.; Leonard & McGovern, sand, 78 cts. per cu. yd.; Patrick Keelty, sand, 73½ and 80 cts.; J. T. Curley, rubble stone, $2.20 per cu. yd.; Schwind & Leonard, stone, $2.10; C. H. Harris, stone, $2.20; Philips, Walsh & Sons, Georgia pine lumber, $12.50 to $21 per 1,000 ft.

GRADING.—St. Louis, Mo.—The Pitzman's Company of Engineers and Surveyors has received the following bids for grading 568,800 cu. yds. at Granite, average haul, 650 ft.: Boehwer & Co., 14½ cts. per cu. yd.; Scott, Hanick & Co., 12⅝; W. B. Strong, Jr., & Co., 14⅜; N. W. Irish & Co., 15.9; Dorwin & Dugon, 21½; for grading 150,000 cu. yds., average haul, 750 ft.: P. E. Donavan, 17½; Tim Scott, 15½; for both contracts: Hayes Bros., 15½ and 16½; McArthur Bros., 15¾, 18½; Thos. C. Grace, 15 1-5, 17½; Allen & Vieths, 14, 15; J. A. Ware, 14⅜, 16⅜; E. H. Bradbury, 12.4, 13½; Fitzgerald & McGinnis, 19.20; W. W. Penny, 12.9, 13.9; Ed. Phelan, 12.9, 13.9; Jno. Scott & Son, 12.49, 13.49; R. M. Quigley & Co., 14½, 16; Manegold & Pardesky, 14½, 16.95.

REPAIRING AQUEDUCT.—Brooklyn, N. Y.—The contract for making repairs to the aqueduct in Ward 26 has been awarded to John McNamee, at $17 per cu. yd. for brick work, 80 cts. for excavations and filling, and $8 for concrete.

MISCELLANEOUS.

JAIL.—Tuscola, Ill.—Bids are asked until June 7 for a jail for Douglas Co. J. W. King, Co. Clk.

CEMENT, Boston, Mass.—Bids will be received at the U. S. Engineer Office until June 20 for 7,500 bbls. of American hydraulic cement, to be delivered at Bennett's Wharf. Lieut.-Col. S. M. Mansfield, U. S. A.

GAS.—Rochester, N. Y.—The Rochester Gas Co. offers to furnish 100 lamps or less, of 25 c. p., at 8½ cts. each per night, 100 to 200 at 8 cts., 200 to 300 at 7½ cts., 300 to 400 at 7 cts., 400 to 500 at 6½ cts., 500 to 1,000 at 6 cts., or 8,000 lamps on a contract for five years at $80,000 per year.

CEMENT.—Atlanta, Ga.—Bids are asked until June 18 for furnishing the city with cement until June 30, 1893. D. G. Wille, Comr. Pub. Wks.

BREAKWATER.—Portland, Me.—Bids will be received at the U. S. Engineer Office until June 18 for a breakwater at Little Harbor, N. H. Lieut.-Col. P. C. Hains, U. S. A.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have orders for 24 simple and 2 compound engines for the Lehigh Valley and two freight engines for the Duluth & Winnipeg; they have delivered three passenger engines to the Baltimore & Ohio. The International & Great Northern has built an eight-wheel engine at its shops at Palestine, Tex., under the supervision of Mr. Hutsmith, Master Mechanic. The Schenectady Locomotive Works, Schenectady, N. Y., have an order for some heavy eight-wheel passenger engines for the Pennsylvania.

THE LIMA LOCOMOTIVE & MACHINE CO., Lima, O., has acquired all the plant, machinery, etc., of the Lima Machine Works, and will carry on the business under practically the same management.

CARS.—The Jackson & Sharp Co., Wilmington, Del., has an order for 12 suburban cars, 8 excursion cars and 4 combination cars for the Staten Island Rapid Transit. The Wells & French Car Co., Chicago, Ill., is building 500 box cars for the Minneapolis, St. Paul & Sault Ste. Marie. The Elliott Car Co., Gadsden, Ala., is building 250 gondola cars for the Louisville & Nashville. The Barney & Smith Mfg. Co., Dayton, O., has an order for 10 passenger cars for the Southern Pacific. The Long Island Parlor Car & Sleeping Car Co., Portland, Me., has been incorporated with a capital of $100,000; Pres., Benjamin Morton, New York. N. Y.; Treas., Wm. J. Kelley, Brooklyn, N. Y. The Lewis & Fowler Co., Brooklyn, N. Y., has an order for 4 open and 4 closed street cars for Springfield, Mass.

RAILS.—The Central Vermont is laying 75 lb. rails purchased from the Lackawanna Iron & Steel Co., of Scranton, Pa. The Jenne Compound Rail Co., New York, has been incorporated by J. A. George, of Woodhaven, N. Y.; J. H. Cain, of Brooklyn, N. Y., and George Smallwood, of New York, N. Y.; capital stock, $3,000,000. The company will deal in rails and track supplies.

PUMPING ENGINE.—The contract for a 10,000,000-gallon, high duty engine, for the water-works of Lancaster, Pa., has been awarded to H. R. Worthington, New York, at $38,000.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., will design and build the new power house for the Newport News Shipbuilding & Dry Dock Co., of Newport News, Va. The side walls will be of brick, the floors of iron and concrete, and the roof made with an iron frame covered with the Berlin Iron Bridge Co.'s patent anti-condensation corrugated iron covering. The steam, compressed air, hot air and electric light plant for the entire shipyard is concentrated in this one building, and it is therefore necessary to make it fireproof.

THE CALIFORNIA ENGINEERING CO., Monon Block, Chicago, has been awarded a contract for furnishing the Albina Light & Water Co., through their Portland (Ore.) office, with one pair of improved Wheelock engines, having 22×36-in. cylinders and the Hill valve gear. Also to furnish a similar pair of engines having 20×42-in. cylinders, to the Indianapolis (Ind.) St. Ry. Co. This company is the Western agent for the Wheelock engine. Pres., Alfred H. Hoadley; Consult. Engr., Joseph H. Hoadley; Sec. and Treas., Geo. W. Hoadley.

THE RAILWAY EQUIPMENT CO., of Chicago, Ill., has been incorporated by C. L. Pullman, A. D. Lundy and W. L. Adams to manufacture and deal in railway supplies and appliances. Capital stock, $100,000.

EVENS & HOWARD, St. Louis, Mo., have commenced extensive improvements and additions to their sewer pipe and fire brick plant, which is said to be the largest in the country. The improvements will consist of thirty 30-ft. round kilns, new steam plant of 600 HP., Corliss engine of 400 HP., with brick buildings, etc.

NEW COMPANIES.—Binghamton Heat & Power Co., to lay steam pipes; Geo. E. Green, J. S. Wells and F. F. Ross. Hudson Construction Co., Jersey City, N. J.; $10,000; P. L. Rehill, J. W. Edwards and K. K. Stearns. Stowell Cement Pipe Co., Los Angeles, Cal., $100,000; N. W. Stowell, Albert Lindley and G. F. Connaut. Columbian Steam Pump Co., Chicago, Ill.; $150,000; C. R. Burnham, T. M. Hoyne and S. C. Reber. Blake Asphalt Co., Denver, Colo.; $500,000; Pres., H. G. Wolff; Secy., W. G. Evans; Gen. Man., F. O. Blake. Kelly Pneumatic Tube Co., Chicago, Ill.; $1,000,000; H. C. Kelly and Mortimer Roberts. Durfee Portland Cement Co., Orange, N. J.; $150,000; M. V. Fuller, New York; Geo. C. Hallet, Orange. West Side Construction Co., Jersey City, N. J.; $3,000,000; C. L. Morgan, of Great Neck, N. Y.; N. J. Moore, of Roselle, N. J.; C. Lyman, of Jersey City, N. J. Economic Railway Equipment Co., Chicago, Ill.; $500,000; J. D. McIlwain, C. E. Kaufman, and W. P. Moore.

CURRENT PRICES.

RAILS.—New York: $30 at Eastern mills, $30.75 at tidewater; old rails, $19.50 for iron and $16 for steel. Pittsburg: $30; old rails, $20 for iron and $15.50 to $16.50 for steel. Chicago: $31.50 to $32; old rails, $18 to $19 for iron and $12.50 for steel.

TRACK MATERIALS.—New York: steel angle bars 1.6 to 1.7 cts.; spikes, 2 to 2.05 cts.; track bolts, 2.65 to 2.75 cts. with square and 2.8 to 2.85 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron and 1.8 to 1.9 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 for iron and 1.75 cts. for steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.55 cts. with square and 2.62 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing 55 per cent.

FOUNDRY PIG IRON.—New York: $14 to $16. Pittsburg: $13.50 to $14.75. Chicago: $13.50 to $15.

LEAD.—New York: 4.25 to 4.3 cts. Chicago: 4.12. St. Louis: 4.05 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.1 to 2.2 cts. for large lots, and 2.25 to 2.45 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 1.95 cts. for tank, 2.05 to 2.25 cts. for shell, 2.35 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts.; channels, 2 to 2.1 cts.; angles, 1.85 to 1.9 cts.; tees, 2.5 cts.; universal mill plates, 1.8 to 1.9 cts. for iron and steel; sheared steel bridge plates, 1.95 to 2 cts.; refined bars, 1.7 for iron and 1.75 cts. for steel; steel plates, 1.75 to 1.85 cts. for tank, 2 to 2.1 cts. for shell, 2.1 2.25 cts. for flange, 3.5 to 4 cts. for firebox. Chicago: beams, 2 cts.; channels, 2 cts.; angles, 1.9 cts.; tees, 2.04 cts.; universal plates, 1.9 cts.; sheared steel plates, 1.95 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.6 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.